FINAL STUDY REPORT

EVALUATION OF CONSIDERATION AND INCORPORATION OF GREEN AND SUSTAINABLE REMEDIATION (GSR) PRACTICES IN ARMY ENVIRONMENTAL REMEDIATION

Prepared for:

Office of the Assistant Chief of Staff for Installation Management (OACSIM)
Installation Services Directorate – Environmental Division

Prepared by:

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VOLUME 2 of 2

Final Report
August 27, 2012

VOLUME 2:

Pilot Project GSR Evaluation Reports

Pilot Project GSR Evaluations Performed by Tetra Tech:

- *Akiachak Federal Scout Armory*
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- *Iowa Army Ammunition Plant*
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- *Schilling Air Force Base Atlas Missile Facility S-1*
- *Former Schilling Atlas Missile Site S-5*

FINAL REPORT

PILOT PROJECT GSR EVALUATION:
AKIACHAK FSA

Federal Scout Armory, Akiachak, AK

Prepared for:

U.S. Army Corps of Engineers
Environmental and Munitions Center of Expertise
1616 Capitol Ave, Suite 9200
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Contract No. W912DQ-08-D-0019
Delivery Order No. ZW02

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10 January 2012

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PREFACE

The US Army Engineering and Support Center, Huntsville (USAESCH), Environmental and Munitions Center of Expertise (EM CX) has contracted Tetra Tech EC, Inc. (Tetra Tech) under Contract W912DQ-08-D-0019, Delivery Order No. ZW02, to conduct and document a Study that follows the process of considering, incorporating, documenting, and evaluating the benefits of green and sustainable remediation (GSR) practices. The objective of this Task Order is to: (1) Follow the consideration and incorporation of GSR practices into Army environmental remediation projects; (2) Ascertain the effectiveness of the GSR practices that are considered and incorporated; and (3) Provide procedures by which GSR practices that are shown to be effective can be identified, considered, implemented and documented by Project Teams working on Army sites. The information obtained from this Study will be used to provide recommendations to the Office of the Assistant Chief of Staff for Installation Management (OACSIM) for development of Army-wide GSR guidance and policy. This document has been prepared in accordance with the Task Order Statement of Work (SOW) entitled "*Evaluation of Consideration and Incorporation of Green and Sustainable Remediation (GSR) Practices in Army Environmental Remediation*" (26 July 2010).

The Project Delivery Team (PDT) consists of representatives and subject matter experts (SMEs) from the following organizations:

- EM CX;
- OACSIM;
- National Guard Bureau (NGB);
- Army Environmental Command (AEC);
- Tetra Tech;
- Office of the Deputy Assistant Secretary of the Army-Environmental Safety and Occupational Health (ODASA (ESOH));
- Headquarters US Army Corps of Engineers (HQ USACE) Formerly Used Defense Sites (FUDS) program;
- HQ USACE Environmental Community of Practice (ECoP) Military Munitions Support Services (M2S2);
- Huntsville Center Environmental Program; and
- Army Environmental Policy Institute (AEPI)

Specific representatives of those organizations are listed on the table at the end of this preface. This report pertains to one of the pilot projects conducted as part of the Study. Tetra Tech personnel who provided the most significant contributions to this report are as follows:

- Preparation
    - Rob Greenwald
    - Sarah Farron

- Review
    - Doug Sutton

Sincere thanks are extended to Project Team associated with this pilot project, for their willingness to participate in this Study and for their efforts that were associated with their participation.

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Doug Sutton, PhD, PE, LEED

____1/10/12____
Date

ACRONYMS AND ABBREVIATIONS

ACSIM	Assistant Chief of Staff for Installation Management
ADEC	Alaska Department of Environmental Conservation
AEC	Army Environmental Command
AEPI	Army Environmental Policy Institute
AK	Alaska
AKMS	Alaska Systems Coordinating Council Miscellaneous
AOC	Area of Concern
AST	Aboveground Storage Tank
BMPs	Best Management Practices
CO2	Carbon dioxide
CO2e	Equivalent Global Warming Potential of Carbon Dioxide
CSM	Conceptual Site Model
DoD	Department of Defense
DRO	Diesel Range Organics
ECoP	Environmental Community of Practice
eGRID	Emissions & Generation Resource Integrated Database
EM CX	Environmental and Munitions Center of Expertise
ESOH	Environment, Safety, and Occupational Health
FSA	Federal Scout Armory
Ft	Feet
FUDS	Formerly Used Defense Sites
GAC	Granular Activated Carbon
GHG	Greenhouse gas
GSR	Green and Sustainable Remediation
HQ USACE	Headquarters US Army Corps of Engineers
HRS	Hours
IRP	Installation Restoration Program
Kg	Kilograms
kWh	Kilowatt-hours
lbs	Pounds
M2S2	Military Munitions Support Services
Mg	Milligrams
MMBtu	Million Metric British Thermal Units
MMRP	Military Munitions Response Program
MWh	Megawatt hours
NGB	National Guard Bureau
NOx	Nitrogen Oxides
NPV	Net present value
O&M	Operations and Maintenance
OACSIM	Office of the Assistant Chief of Staff for Installation Management
ODASA	Office of the Deputy Assistant Secretary of the Army
OR	Oregon
PDT	Project Delivery Team
PM	Particulate Matter
POTW	Publicly Operated Treatment Works
RAP	Remedial Action Plan
RECs	Renewable Energy Certificates
SiteWise	Battelle SiteWise™ Sustainable Environmental Remediation Tool

SMEs	Subject matter experts
SOW	Statement of Work
SOx	Sulfur Oxides
US	United States
USACE	United States Army Corps of Engineers
USAESCH	US Army Engineering and Support Center, Huntsville
WA	Washington

1.0 INTRODUCTION

1.1 ACSIM GSR STUDY AND PURPOSE OF THIS GSR EVALUATION

The US Army Engineering and Support Center, Huntsville (USAESCH), Environmental and Munitions Center of Expertise (EM CX) has contracted Tetra Tech EC, Inc. (Tetra Tech) under Contract W912DQ-08-D-0019, Delivery Order No. ZW02, to conduct and document a Study that follows the process of considering, incorporating, documenting, and evaluating the benefits of green and sustainable remediation (GSR) practices (hereafter referred to as "the Study"). The objective of the Study is to: (1) Follow the consideration and incorporation of GSR practices into Army environmental remediation projects; (2) Ascertain the effectiveness of the GSR practices that are considered and incorporated; and (3) Provide procedures by which GSR practices that are shown to be effective can be identified, considered, implemented and documented by project teams working on Army sites. The information obtained from this Study will be used to provide recommendations to the Office of the Assistant Chief of Staff for Installation Management (OACSIM) for development of Army-wide GSR guidance and policy.

One component of the Study described above is to perform a GSR evaluation at 12 Army "Pilot Projects" that are in various phases of the remedial process. This report presents the Pilot Project GSR Evaluation for the environmental restoration activities at the Federal Scout Armory (FSA) in Akiachak, AK (hereafter referred to as the "Akiachak FSA"). This GSR evaluation has been conducted using an approach developed during the Study and documented in the following report: *Process for Consideration and Incorporation of Green and Sustainable Remediation (GSR) Practices in Army Environmental Remediation (final report dated 26 May 2011).* One purpose for the pilot projects is to provide testing of the GSR approach developed during the Study, and that approach will be refined and finalized later in the Study based on lessons learned from this and other pilot projects. In addition, it is anticipated that this GSR evaluation will provide the Project Team for the Akiachak FSA with information and/or recommendations that will be beneficial for their project.

This report refers to "teams" that are defined as follows:

- Study Team: This is the team conducting a Study being led by USACE EM CX that follows the process of considering, incorporating, documenting, and evaluating the benefits of green and sustainable remediation practices for Army projects.

- Project Team: Refers to those associated with implementation of the remedial process for the pilot projects.

- GSR Team: Refers to the personnel that perform a specific GSR evaluation. For this Study, the GSR Team consists of personnel from Tetra Tech, which is a contractor to USACE for the Study.

In this Study, an "EM CX liaison" for each of the pilot projects serves as a bridge between the USACE Study project manager (Carol Dona), the Study contractor performing the GSR evaluation (Tetra Tech), and the Project Team manager for the specific pilot. For this pilot project the EM CX Liaison is Mark Rothas.

1.2 TECHNICAL OVERVIEW: AKIACHAK FSA

1.2.1 Overview of Site Location, Setting, and Contamination

The village of Akiachak is located along a slough draining into the Kuskokwim River, 18 miles northeast of Bethel, Alaska. The site layout is illustrated on Figure 1-1. The Akiachak FSA consists of a 2.75 acre area with one 20-foot by 60-foot Butler-style building constructed in 1960 (referred to as the "Old Armory") and one 30-foot by 50-foot building built after 1990 (referred to as the "New Armory"). The buildings are connected by a walkway. A 1,500-gallon and a 3,000-gallon heating oil aboveground storage tank (AST) are located on the east side of the buildings. A conex storage van is located on the west side of the New Armory building. Gravel roads run through the FSA property along the north, south, and west boundaries.

Heating oil spills/releases from the former feed line connecting the former 3,000-gallon AST to the Old Armory and the former pipeline appear to be the primary known source of contamination. Diesel range organics (DRO) in shallow soils above the cleanup level of 250 mg/kg is the primary contaminant of concern.

1.2.2 Remedial Phase and Status

In June 2010, Ahtna conducted remedial actions at the Akiachak FSA consisting of excavation and off-site disposal of approximately 280 tons of DRO-contaminated soil from the west side of the Old Armory. During the 2010 remedial activities, a second area of concern (AOC) with DRO-contaminated soil was discovered on the east side of the Old Armory. DRO concentrations in six soil samples collected from this AOC ranged from non-detect to 3,750 mg/kg. Another excavation to address contamination in this new AOC is scheduled for June 2011. This planned excavation and soil disposal scheduled for Summer 2011 is the focus of this GSR evaluation.

This is a very remote site which requires special considerations for planning and implementing a remedial action. Personnel need to be transported to the village via air transport, and there are limited options for soil disposal. The remedy includes barge transport of the excavated soil from Akiachak to Bethel to Seattle (on regularly scheduled barges), with ultimate disposal in Arlington, Oregon. There is a relatively new thermal treatment plant in Bethel, Alaska (approximately 18 miles from Akiachak) that could address the excavated soil, but the Project Team indicated that they believe this would result in higher overall cost compared to the barge transport to Seattle and subsequent landfill disposal.

This GSR evaluation provides an evaluation of the selected remedy with respect to specific GSR metrics, and also highlights how specific GSR Best Management Practices (BMPs) have been implemented in previous remedial activities and/or could be implemented during the planned remedial action at this site and others like it. Since there are 21 FSA sites in Alaska with similar parameters and site conditions to Akiachak, two of which are already contracted, the findings of this evaluation could inform decisions made for future activities at these other sites. This GSR evaluation does not in any manner include an evaluation or judgment of the protectiveness of the selected remedy.

1.3 DOCUMENTS REVIEWED AND CALLS/MEETINGS CONDUCTED

The following project documents were reviewed for this evaluation:

- *Final Remedial Action Plan Addendum* (Ahtna, 3 January 2011)
- *Final Remedial Action Plan* (Ahtna, 27 May 2010)
- *Draft Supplemental Site Characterization Report* (Ahtna, 14 January 2010)
- *Record of Decision* (March/April 2010)
- *Performance Work Statement* (2009)
- *Site Investigation Report* (CH2M HILL, January 1996)

As per the GSR approach being implemented in the Study, an introductory conference call (referred to as the "Step 3" call) was conducted on 21 January 2011. Items discussed on this call included the following:

- The schedule of the GSR evaluation was discussed within the context of how the GSR evaluation could best be integrated into the overall efforts and schedule of the Project Team.
- The possibility of doing a GSR evaluation for an in-situ treatment option, such as application of a microbial product, was discussed. It was discussed that a GSR evaluation would likely show that such an approach is greener, which could impact future evaluations by regulators (if not for this site than perhaps for other sites). There are a total of 21 sites with similar parameters and site conditions to Akiachak, two of which are already contracted. This site could perhaps be used as a test site for a different remedy option such as application of a microbial product, and GSR evaluations of remedy alternatives for this project could help with remedy selection for future projects.
- The subsequent "Step 5" call, which would serve as a primary mechanism for the GSR Team and Project Team to exchange information and ideas, was scheduled for 4 March 2011 (subsequent to the "Step 3" call, the "Step 5" call was later rescheduled for 11 March 2011).

Participants for the "Step 3" call are listed in Table 1-1.

Table 1-1
Step 3 Call Participants, 21 January 2011

Participants			
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A more detailed conference call, referred to as the "Step 5" conference call, was conducted on 11 March 2011 and lasted two and a half hours. During this call the GSR Team used the list of GSR BMPs developed for the Study as an outline to ask questions to the Project Team and allow the Project Team to provide pertinent information to the GSR Team. Participants for the "Step 5" call are listed in Table 1-2.

Table 1-2
Step 5 Call Participants, 11 March 2011

Participants			
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1.4 STRUCTURE OF THIS REPORT

This GSR evaluation report is structured as follows:

- Section 1: Introduction
- Section 2: Key GSR Findings
    - Review of BMPs
    - Quantitative Footprint Analysis for Alternative 1 (Excavation and Off-Site Disposal – Baseline Option)
    - Footprint Impacts for Alternative 2 (On-Site Biological Treatment)
    - Footprint Impacts for Alternative 3 (Ex-Situ Thermal Treatment)
    - Other Qualitative Considerations
- Section 3: GSR Recommendations

Supporting information and calculations for quantitative aspects of the evaluation are provided in appendices, and spreadsheet files for the SiteWise tool are attached electronically.

2.0 KEY GSR FINDINGS

2.1 REVIEW OF BEST MANAGEMENT PRACTICES (BMPs)

2.1.1 BMP Tables Completed by GSR Team

The GSR Team and the Project Team used a list of GSR BMPs as an outline to exchange information and ideas pertinent to application of GSR practices for this pilot project. The GSR Team subsequently completed the BMP tables included in Appendix A, based on the data provided by the Project Team in the form of documents as well as discussions during the Step 5 conference call. Table 2-1 summarizes information entered on the BMP tables in Appendix A, specifically with respect to the number of BMPs that appear to be applicable for this pilot project, the number of BMPs that appear to be practical for this pilot project, the number of BMPs that have been implemented prior to this GSR evaluation, and the number of BMPs that maybe associated with potential cost savings for this pilot project.

Table 2-1
Summary of BMP Applicability and Implementation from BMP Tables in Appendix A

	BMP Category								
	A. Planning	B. Characterization and/or Remedy Approach	C. Energy/Emissions Transportation	D. Energy/Emissions Equipment Use	E. Materials & Off-site Services	F. Water Resource Use	G. Waste Generation, Disposal, and Recycling	H. Land Use, Ecosystems, and Cultural Resources	I. Safety and Community
Total Number of BMPs	10	9	4	11	5	5	6	7	7
Number of Applicable BMPs	9	6	3	3	4	1	3	3	4
Number of Practical BMPs	8	6	3	1	4	1	1	3	3
Number of BMPs Implemented Prior to GSR Evaluation									
- Fully	6	6	3	1	2	1	1	3	3
- Partially	1	0	0	0	2	0	0	0	0
- Not Yet	1	0	0	0	0	0	0	0	0
Number of Practical BMPs Likely to Result in Cost Savings	3	5	2	1	4	1	1	0	2

2.1.2 Key Findings Regarding BMPs

An overview of key findings regarding application of the BMPs to this pilot project is provided below.

- The Project Team has already considered many of the BMPs prior to this GSR evaluation. The remoteness of the area leads to high costs for limited resources (such as fuel, water, and treatment chemicals) as well as limited options for transporting equipment, materials, and people to the site. The unique conditions at this site have driven the implementation of a number of the BMPs. Examples include the following:

    - Utilizing teleconferencing whenever possible due to the remoteness of the site.

    - Using quick turnaround samples from the lab to eliminate the need for re-mobilization.

    - Limiting the amount of material that will be excavated, transported, and disposed of by using field screening methods to determine the extent of contamination and using staging areas to separate contaminated and potentially clean soil. Soil that does not appear contaminated is sampled and, if clean, used for backfill.

    - Dividing excavation projects into pieces so that work can continue while waiting for sample results. This leads to less downtime and therefore fewer days in the field.

    - Utilizing pre-established transport for mobilizing the site team and disposing of excavated soils, so remedial activities will not increase fuel use.

    - Minimizing engine idle times and hours of equipment operation to reduce fuel use. This is particularly important in this area due to the high cost and limited availability of fuel.

    - Scheduling field activities for the appropriate season. Excavation needs to take place when the ground is firm, but not too hard to remove all of the contaminated soil. However, the permafrost in the area of excavation also needs to be preserved. Work is typically done at night or early morning when sunlight is less intense and a tarp is used to minimize melting of the permafrost. On-site work begins early in the morning to minimize disturbances to the community, since most activity occurs in the afternoon.

    - A pulp cellulose material made from crushed alder trees and produced in Alaska will be used as a polishing step in place of a second GAC unit.

    - Utilizing local contractors, equipment, and materials when possible to benefit the local community. At Akiachak and other sites in Alaska, field teams often stay at the school (for a donation) or at apartments owned by the village, which also benefits the community.

- While going through the BMP list on the Step 5 call, the GSR Team suggested several items that the Project Team could consider moving forward. Some examples include the following:

    - Including a section in the final report after the remedy is performed that documents GSR considerations that were considered and implemented as part of the remedial action.

- Submitting appendices and lab reports for future deliverables electronically to save paper and perhaps shipping. Though lab reports for this site are fairly short, this would be a good practice for the other sites in Alaska.

- Using an in-situ treatment rather than excavation and offsite disposal was initially suggested by the GSR Team (using a microbial product as an example), but cannot be applied at this site because this type of in-situ treatment has not been approved by the regulators in Alaska. This could be applied at one of the other sites if successful remediation using a microbial product (or another form of in-situ treatment) has been demonstrated in an area with similar weather and temperature conditions. The Project Team indicated that land farming in Alaska is approved by ADEC, but the use of a microbial product would require a local strain of microbes to be cultured and rehydrated for application to the site.

- The Project Team identified that some BMPs are not practical to implement because of other project-specific constraints. Examples include the following:

  - Purchasing Renewable Energy Certificates (RECs) to offset footprints associated with electricity usage is not considered to be practical because it increases costs, which is seen as a higher priority.

  - Using site-specific cleanup standards or allowing re-use options that include restricted use are not options at this site or others in Alaska, since the state requires that they be remediated to unrestricted use.

  - Selecting equipment that is the appropriate size for the area to be excavated is not always an option at sites in this area. The Project Team is typically forced to use what is locally available, since the cost and emissions for transport to the site would outweigh any benefits of having more appropriately sized equipment.

2.2 QUANTITATIVE FOOTPRINT ANALYSIS FOR ALTERNATIVE 1 (BASELINE)

2.2.1 <u>Overview of Alternative 1 (Excavation and Off-Site Disposal – Baseline Option)</u>

The baseline remedy option (Excavation and Off-Site Disposal) is the remedy currently described in the Final RAP Addendum:

- Mobilize personnel, equipment, and materials to the Akiachak FSA;

- Locate and excavate DRO-contaminated soil on the east side of the Old Armory;

- Field screen excavated soil, as applicable;

- Collect confirmation soil samples from excavated areas for laboratory analysis in Anchorage;

- Treat water that collects in excavation with GAC polished by alder wood, discharge treated water to ground, and dispose of GAC and alder in landfill in Anchorage;

- Backfill using sand from nearby borrow area (~$^1/_4$ mile from the site), re-grade, and re-vegetate areas disturbed by project activities;

- Arrange for the off-site transportation and disposal of the excavated DRO-contaminated soil;

  - Transport from the excavation area to the barge landing area ($^1/_2$ - $^1/_4$ miles). The loader will be used to transport super sacks.

  - Transport via barge from Akiachak to Seattle, WA (~3000-3500 miles):
    - The excavated material will likely account for ~$^1/_2$ of the barge's load from Akiachak to Bethel.
    - It will likely take up ~$^1/_8$ of the barge load from Bethel to Seattle, which would typically be nearly empty.

  - Transport via truck from the shipyard in Seattle to railroad station ~5 miles away.

  - Transport via rail ~250-300 miles to Arlington, OR.

  - Note: all transport is "piggybacking" on transport that would already have taken place. Therefore, the footprint will be calculated based only on the added fuel use due to the additional weight of the excavated material.

- Demobilize personnel, equipment, and materials from the Akiachak FSA.

Input to the SiteWise tool and other supporting calculations are described in Appendix B.

2.2.2 Summary of Quantitative Footprint Results, Alternative 1 (Baseline)

Table 2-2 summarizes the quantitative footprint results for Alternative 1. Input to the SiteWise tool (Version 1) and other supporting calculations are described in Appendix B. The SiteWise files utilized for this portion of the analysis are supplied electronically ("Alternative 1").

Table 2-2 divides total energy use and global warming potential into "direct" and "indirect" use and emissions. The following definitions are utilized for "direct" versus "indirect" energy use and global warming potential:

- Direct Scope 1: From sources that are owned or controlled by the reporting entity.

- Indirect Scope 2: Due to activities of the reporting entity, but occur at sources owned or controlled by another entity, from consumption of purchased electricity, heat or steam.

- Indirect Scope 3: Due to activities of the reporting entity, but occur at sources owned or controlled by another entity, other than Scope 2 (such as the extraction and production of purchased materials and fuels, transport-related activities in vehicles not owned or controlled by the reporting entity, outsourced activities, waste disposal, etc.

SiteWise Version 1 reports total energy use and total global warming potential, but does not sum the "direct" and "indirect" components. The user needs to track the distinction between "direct" and "indirect" components separately, based on information contained within the SiteWise spreadsheets. The separation of the total energy and global warming potential is documented in Appendix B, which describes SiteWise input and related calculations.

Table 2-2
Summary of Quantitative Footprint for Alternative 1 (Baseline)

GSR Parameter	Unit	Value
Environmental		
Energy – Total	MMBtu	494
Energy – Direct Scope 1	MMBtu	106
Energy – Indirect Scope 2	MMBtu	0.01
Energy – Indirect Scope 3	MMBtu	388
% of Energy from Renewable Resources	%	negligible
Global warming potential – Total	Metric tons CO2e	42
Global warming potential – Direct Scope 1	Metric tons CO2e	6
Global warming potential – Indirect Scope 2	Metric tons CO2e	0.0002
Global warming potential – Indirect Scope 3	Metric tons CO2e	36
Criteria air pollutant emissions	Metric tons (NOx+SOx+PM)	144
Hazardous air pollutant emissions	Lb	negligible
Potable water use	1,000s of gallons	negligible
Other water use	1,000s of gallons	negligible
Refined materials use	Lbs	40
% of refined materials from recycled material	%	0%
Unrefined materials use	Ton	0.025
% of unrefined materials from recycled material	%	100%
Non-hazardous waste generation	Ton	172.5
Hazardous waste generation	Ton	0
% of potential waste that is recycled or reused	%	0%
Land transferred or made available for beneficial use	Acres	0.01
Existing ecosystem destruction	Acres	0
Time frame for land reuse	Years	1
Flexibility and breadth of options for reuse	see below	1
Economic		
Life-cycle Cost, Discounted (3% discount rate)	$	$335,533
Life-cycle Cost, Undiscounted	$	$335,533
Up-front Cost	$	$335,533
Societal		
Predicted number of injuries or fatalities for On-Site Worker	Number of injuries or fatalities	4E-03
Predicted number of injuries or fatalities associated with transportation	Number of injuries or fatalities	3E-05
One-Way Heavy Vehicle Trips through Res. Area	Trips	many

**Scale for flexibility and breadth of re-use options (greater GSR value with lower number, indicating more breadth and flexibility for potential re-use)*

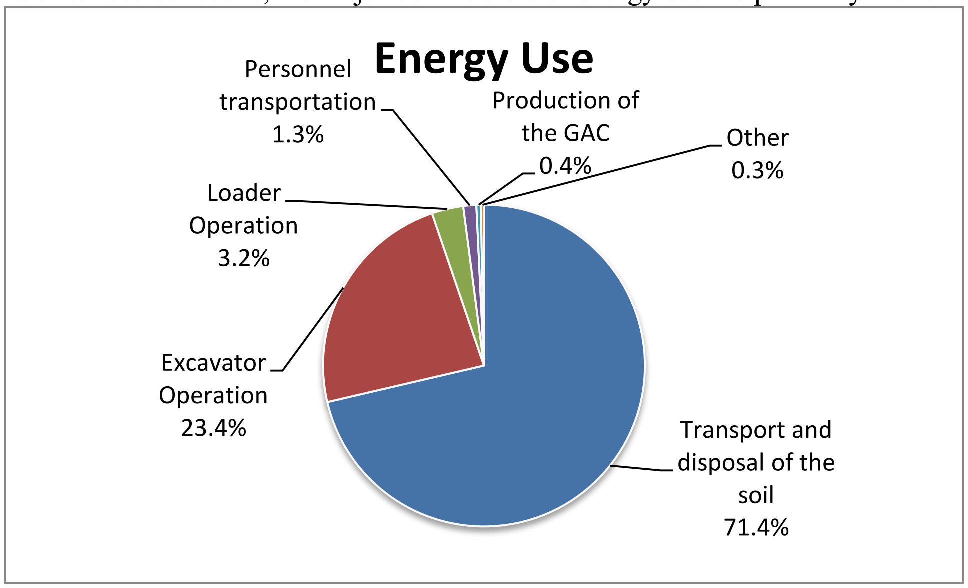
1 - Unlimited re-use options
2 - Limited re-use options
3 - Only one re-use option

2.2.3 Key Findings from Quantitative Footprint Analysis, Alternative 1 (Baseline)

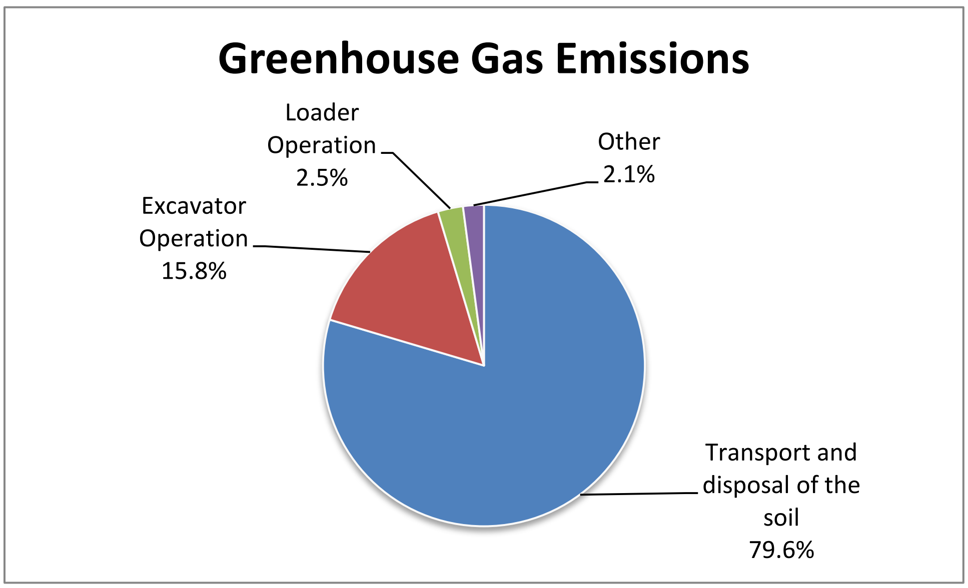
Review of the SiteWise results and supporting calculations in Appendix B indicates the following key findings with respect to the Baseline remedy design:

- From SiteWise, total energy usage is 494 MMBtu, and electricity use (which is only for the pump used to treat water in the excavation) accounts for a negligible amount of this total (0.008 MMBtu). According to eGRID (http://cfpub.epa.gov/egridweb/view_srl.cfm), the percentage of electricity from renewable sources for region AKMS is ~66% (most of which is hydropower), but the amount from renewable energy at this site is still negligible because electricity use represents such a small portion (<0.01%) of the overall energy use for this remedy, which is dominated by transportation and equipment use.

- Based on SiteWise results, the major contributors of energy use are primarily the following:



- Based on SiteWise results, greenhouse gas emissions of 42 metric tons CO2e are primarily due to the following:



- With respect to criteria pollutants, the dominant contributor to NOx and SOx and PM is associated with transport and disposal of the soil.

- The emission of hazardous air pollutants is negligible because treatment does not involve stripping of volatile organic chemicals.

- There is essentially no water use, except for a very minor amount associated with production of electricity that is used for a pump. Rain water could be collected for minor on-site water uses, such as equipment decontamination.

- The refined materials consist of the following (assumed to be 100% virgin material):

    - ~40 lbs of GAC

- The unrefined materials consist of the following (assumed to be 100% recycled):

    - ~50 lbs of alder mulch

- The project does not involve hazardous waste generation. Non-hazardous waste consists of the excavated soil (172.5 tons) plus the used GAC and alder (0.045 tons).

- The remedy will return the land to unrestricted use. This is a very small area that is impacted. Based on Figure 1-1 the impacted area appears to be approximately 20 ft by 20 ft, which is on the order of 0.01 acres.

- A table summarizing the calculation of life-cycle cost (discounted and undiscounted) is included in Appendix B. Cost estimates are based on a cost estimate for remedial actions from Ahtna. This information was provided to the GSR Team via email attachment from Jennifer Nutt on 14 April, 2011. Information regarding the cost calculations is as follows:

    - The capital cost for the selected remedy (baseline option) is $335,533.

    - There is assumed to be no annual O&M cost for this remedy, since the planned action will remediate to unrestricted use.

    - Since there are no annual costs, the life-cycle cost equals the capital cost.

    - NPV is calculated by discounting future costs to present-day dollars using the following equation (again, does not really apply to this project):

$$PV = \frac{FV}{(1+i)^n} = C \times FV$$

PV is the present value
FV is the value in year "n" (i.e., future value)
i is the discount rate
C is the discount factor, which equals $1/(1+i)^n$

- SiteWise calculates safety risk for transportation and based on use of heavy machinery. Based on SiteWise results, it would be expected that there would be 0.004 injuries or fatalities over the duration of this alternative, and the primary contributors to safety risk are as follows:

- o Nearly all (>99%) of the safety risk is associated with use of the on-site equipment, and less than 1% of the safety risk is due to transportation. For the use of equipment, the safety risk is calculated by SiteWise to be roughly equal for the excavator and the loader (i.e., similar number of hours).

2.3 FOOTPRINTING FOR ALTERNATIVE 2 (ON-SITE BIOLOGICAL TREATMENT)

The GSR Team also performed footprinting for a potential option that would utilize on-site biological treatment using a microbial product, which contains a blend of wetting agents, nutrients and several strains of bacteria. This material can be added to hydrocarbon-impacted soil to break down the contaminants into smaller molecules for more efficient degradation by the microbes into harmless byproducts like carbon dioxide, water and trace salts. Tetra Tech GEO has successfully applied this to DRO-impacted soil in Michigan. At this site and others in Alaska, special consideration would need to be taken when applying this type of remedy to ensure that permafrost layers are not thawed during the process. Other soil amendment options are also available to stimulate in-situ bioremediation, but for the purposes of this GSR evaluation a microbial product is assumed. It should be noted that while land farming in Alaska is approved by ADEC, the use of a microbial product would require a local strain of microbes to be cultured and rehydrated for application to the site.

Assumptions for this alternative include the following:

- The application of microbial product would likely take approximately one day. There are several options for application of such products, but for the purposes of this evaluation it is assumed that this would include alternating between spraying the product onto the soil and using an excavator to till the contaminated soil in order to distribute the product effectively. The use of an excavator for the tilling will allow tilling over the whole depth of the impacted soil, rather than just the top of the soil. At no time will there be an open excavation area for any extended period, so the need for GAC treatment of water that might collect in such an excavation is eliminated. It is assumed that soil moisture will be sufficient and no further addition of water will be required, given that the summer is the wettest time of year, and the Project Team indicated that there is sufficient moisture to preclude any need for dust control during construction.
- The GSR Team contacted Verde Environmental, Inc., a vendor that produces a microbial product called Micro-Blaze, to obtain an estimate of the amount of material that would be needed and how it could be applied at this site. The vendor was given the following basic information about the contamination at Akiachak FSA:
    - o ~115 cubic yards of Diesel Range Organic (DRO) compounds contaminated soil at concentrations up to 3,750 mg/kg
    - o Contamination is likely limited to the upper 5 ft of soil
    - o The entire area will need to be remediated to 250 mg/kg
- Based on the above information, the vendor indicated that this remedy would require approximately 15 gallons of microbial product diluted with water to a 6% solution, which would require approximately 235 gallons of water. The Project Team has indicated that since water resources are limited in this area, water would need to be purchased by the gallon from a local source. With some advance planning it could be possible to collect rainwater for this purpose, but the footprinting does not make that assumption.

- The footprinting assumes air transport of the microbial product from Anchorage, since the microbial product vendor that was contacted has a distribution center in Anchorage.
- It is assumed that the number of workers required for applying the on-site treatment will remain approximately the same as in the baseline option (though less time in the field than the baseline option). As with the microbial product application, several options for delineating the contaminated area exist. For this evaluation, assume that samples will be collected for lateral and horizontal delineation just prior to treatment and sent to the lab for quick-turnaround. In all, it is assumed that this remedial action will require approximately one week of field work (one mobilization), versus three weeks for the baseline option.
- The footprint assumes that only one application of the soil amendment will be required. Another sampling trip would be required the next season to confirm the remedy was successful. It is assumed for this site that this sampling can be performed by the local subcontractor using a hand-auger. It will require shipping two coolers to and from the site.
- The estimated footprint for this alternative (discussed below) can be doubled to conservatively estimate the footprint for a contingency scenario that would include a second application of the soil amendment (if needed).

Table 2-3 summarizes the footprint results for Alternative 2 compared to the results for the baseline in Alternative 1. Input to the SiteWise tool and other supporting calculations for Alternative 2 are described in Appendix C-1. A cost spreadsheet is also included in Appendix C-1.

Table 2-3
Summary of Quantitative Footprint for Alternative 2 versus Alternative 1

GSR Parameter	Unit	Alternative 1 Value	Alternative 2 Value
Environmental			
Energy – Total	MMBtu	494	30
Energy – Direct Scope 1	MMBtu	106	18
Energy – Indirect Scope 2	MMBtu	0.01	0
Energy – Indirect Scope 3	MMBtu	388	12
% of Energy from Renewable Resources	%	negligible	negligible
Global warming potential – Total	Metric tons CO2e	42	2.0
Global warming potential – Direct Scope 1	Metric tons CO2e	6	1.0
Global warming potential – Indirect Scope 2	Metric tons CO2e	0.0002	0
Global warming potential – Indirect Scope 3	Metric tons CO2e	36	1.0
Criteria air pollutant emissions	Metric tons (NOx+SOx+PM)	144	1.36
Hazardous air pollutant emissions	Lb	negligible	negligible
Potable water use	1,000s of gallons	negligible	0.235
Other water use	1,000s of gallons	negligible	negligible
Refined materials use	Lbs	40	120
% of refined materials from recycled material	%	0%	0%
Unrefined materials use	Ton	0.025	0
% of unrefined materials from recycled material	%	100%	N/A
Non-hazardous waste generation	Ton	172.5	0

GSR Parameter	Unit	Alternative 1 Value	Alternative 2 Value
Hazardous waste generation	Ton	0	0
% of potential waste that is recycled or reused	%	0%	N/A
Land transferred or made available for beneficial use	Acres	0.01	0.01
Existing ecosystem destruction	Acres	0	0
Time frame for land reuse	Years	1	1
Flexibility and breadth of options for reuse	see below	1	1
Economic			
Life-cycle Cost, Discounted (3% discount rate)	$	$335,533	$103,115
Life-cycle Cost, Undiscounted	$	$335,533	$103,115
Up-front Cost	$	$335,533	$103,115
Societal			
Predicted number of injuries or fatalities for On-Site Worker	Number of injuries or fatalities	4E-03	4E-04
Predicted number of injuries or fatalities associated with transportation	Number of injuries or fatalities	3E-05	1E-06
One-Way Heavy Vehicle Trips through Res. Area	Trips	many	fewer

**Scale for flexibility and breadth of re-use options (greater GSR value with lower number, indicating more breadth and flexibility for potential re-use)*

1 - Unlimited re-use options
2 - Limited re-use options
3 - Only one re-use option

Primary Footprints That Would Improve

As would be expected, elimination of the excavation and transport of contaminated soil reduces or eliminates nearly all of the footprints, including the following:

- Energy use is largely eliminated (reduced by 94%).
- Emissions of greenhouse gases are largely eliminated (reduced by more than 95%).
- Emissions of criteria pollutants are nearly eliminated (reduced by more than 99%).
- Waste generation and disposal for the contaminated soil is eliminated.
- Cost is reduced from $335,533 to $103,115.
- Risk of injury or fatality is reduced because the transport of contaminated soil and some transport of equipment are eliminated (though risks in both cases are quite low).
- Though not quantified, one-way heavy vehicle trips through residential areas will be greatly reduced because the use of the loader to move super sacks and transport sand from the borrow area to the site is eliminated.

Primary Footprints That Would Worsen

A few footprints would worsen, including the following:

- Potable water use would increase from negligible to ~235 gallons for dilution of the microbial product.

- Refined materials use triples (from 40 lbs to 120 lbs) due to the tradeoff between the use of GAC in the baseline option and the use of microbial product in Alternative 2.

Technically the percentage of unrefined materials from recycled sources would be reduced from 100%, but that is somewhat misleading because it is due to the elimination of the use of the alder wood used as a polishing step for the GAC, and not using any materials is better than using recycled materials.

2.3.1 Alternative 2A - Contingency For a Second Soil Amendment the Next Field Season

As mentioned above, the estimated footprint for this alternative can be doubled to conservatively estimate the footprint for a contingency scenario that would include a second application of the soil amendment (if needed) the subsequent field season. Based on this conservative approach, the overall cost would still be lower than the baseline, and key footprints would still be much lower than the baseline. For instance, if energy use is doubled from 30 MMBtu to 60 MMBtu for a second round of treatment, it will still be much lower than the 494 MMBtu for the baseline. Similarly, if CO2e is doubled from 2 metric tons to 4 metric tons for a second round of treatment, it will still be much lower than the 42 metric tons for the baseline.

2.4 FOOTPRINTING FOR ALTERNATIVE 3 (EX-SITU THERMAL TREATMENT)

The GSR Team also performed footprinting for a potential option that would utilize off-site thermal treatment at a thermal plant in Bethel. SiteWise inputs for this alternative are similar to those for the baseline option. However, the transport distance for excavated soil is much shorter, since the soil will need to be transported only 25 miles from Akiachak to Bethel, rather than over 3000 miles from Akiachak to the disposal facility in Oregon. The footprinting also makes an attempt to quantify the fuel and materials used during thermal treatment.

Assumptions for this alternative include the following:

- Mobilize and demobilize personnel, equipment, and materials to the Akiachak FSA;
- Locate and excavate DRO-contaminated soil on the east side of the Old Armory;
- Field screen excavated soil, as applicable;
- Collect confirmation soil samples from excavated areas for off-site laboratory analysis;
- Treat water that collects in excavation with GAC polished by alder wood, discharge treated water to ground, and disposed of GAC and alder in landfill in Anchorage;
- Backfill, re-grade, and re-vegetate areas disturbed by project activities;
- Arrange for off-site thermal treatment of the excavated DRO-contaminated soil;
    - A thermal treatment plant in Bethel has been approved for use by regulators.
    - Treatment would presumably involved barge transport from Akiachak to Bethel (similar to the baseline alternative), but then use truck transport to the thermal plant rather than continuing on barge to Seattle).

- The cost of thermal treatment is currently estimated at $400 per ton (provided by the Project Team).

Table 2-4 summarizes the footprint results for Alternative 3 compared to the results for the baseline in Alternative 1. Input to the SiteWise tool and other supporting calculations for Alternative 3 are described in Appendix C-2. A cost spreadsheet is also included in Appendix C-2. With respect to cost, the items that change versus the baseline are: 1) higher cost for contaminated soil disposal ($69,000 versus $20,873 in the baseline); and 2) lower cost for contaminated soil transport ($8,625 versus $127,979 in the baseline). The net change is a significant cost reduction versus the baseline.

Table 2-4
Summary of Quantitative Footprint for Alternative 3 versus Alternative 1

GSR Parameter	Unit	Alternative 1 Value	Alternative 3 Value
Environmental			
Energy – Total	MMBtu	494	160
Energy – Direct Scope 1	MMBtu	106	115
Energy – Indirect Scope 2	MMBtu	0.01	1
Energy – Indirect Scope 3	MMBtu	388	44
% of Energy from Renewable Resources	%	negligible	negligible
Global warming potential – Total	Metric tons CO2e	42	7.4
Global warming potential – Direct Scope 1	Metric tons CO2e	6	4.9
Global warming potential – Indirect Scope 2	Metric tons CO2e	0.0002	0.05
Global warming potential – Indirect Scope 3	Metric tons CO2e	36	2.5
Criteria air pollutant emissions	Metric tons (NOx+SOx+PM)	144	2.6
Hazardous air pollutant emissions	Lb	negligible	negligible
Potable water use	1,000s of gallons	negligible	negligible
Other water use	1,000s of gallons	negligible	negligible
Refined materials use	Lbs	40	40
% of refined materials from recycled material	%	0%	0%
Unrefined materials use	Ton	0.025	0.025
% of unrefined materials from recycled material	%	100%	100%
Non-hazardous waste generation	Ton	172.5	0
Hazardous waste generation	Ton	0	0
% of potential waste that is recycled or reused	%	0%	~100%
Land transferred or made available for beneficial use	Acres	0.01	0.01
Existing ecosystem destruction	Acres	0	0
Time frame for land reuse	Years	1	1
Flexibility and breadth of options for reuse	see below	1	1
Economic			
Life-cycle Cost, Discounted (3% discount rate)	$	$335,533	$264,306
Life-cycle Cost, Undiscounted	$	$335,533	$264,306
Up-front Cost	$	$335,533	$264,306

GSR Parameter	Unit	Alternative 1 Value	Alternative 3 Value
Societal			
Predicted number of injuries or fatalities for On-Site Worker	Number of injuries or fatalities	4E-03	2E-03
Predicted number of injuries or fatalities associated with transportation	Number of injuries or fatalities	3E-05	6E-5
One-Way Heavy Vehicle Trips through Res. Area	Trips	Many	Many

**Scale for flexibility and breadth of re-use options (greater GSR value with lower number, indicating more breadth and flexibility for potential re-use)*

1 - Unlimited re-use options
2 - Limited re-use options
3 - Only one re-use option

<u>Primary Footprints That Would Improve</u>

This alternative, which eliminates transport of materials to Seattle and subsequent disposal in a landfill in Oregon, substantially reduces many of the key footprints including the following:

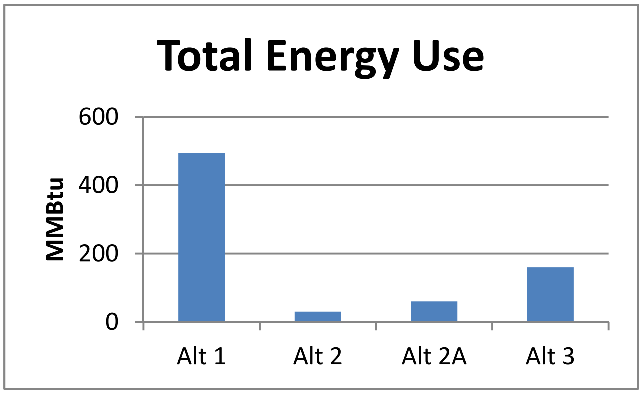
- Energy use is reduced by approximately 68%.
- Emissions of greenhouse gases are reduced by approximately 82%.
- Emissions of criteria pollutants are reduced by approximately 98%.
- Waste generation and disposal for the contaminated soil is eliminated (assuming the soil can be reused), and therefore the percentage of potential waste that is recycled or reused increases to ~100%.
- Cost is reduced from $335,533 to $264,306. Note the Project Team indicated on the Step 5 call that they expected costs for this alternative to be higher than for the baseline, but the GSR Team believes the cost of the incineration is more than offset by the reduced cost for transport relative to the baseline, based on the assumptions regarding transport of contaminated soil to the thermal plant in Bethel, such that net cost will be lower.

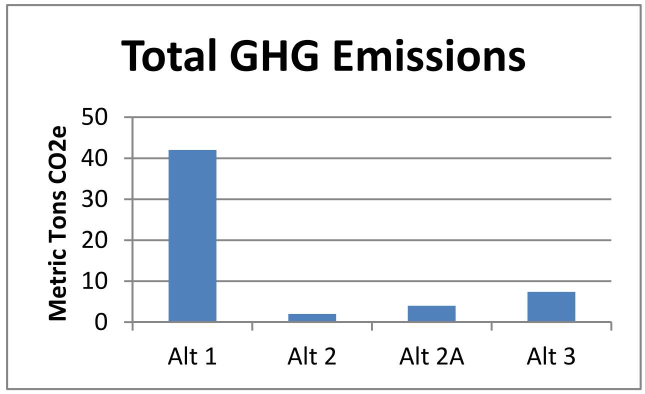
<u>Primary Footprints That Would Worsen</u>

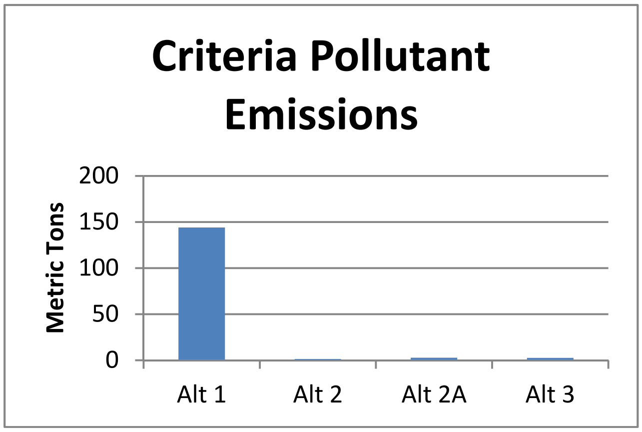
There is no significant worsening of any footprints.

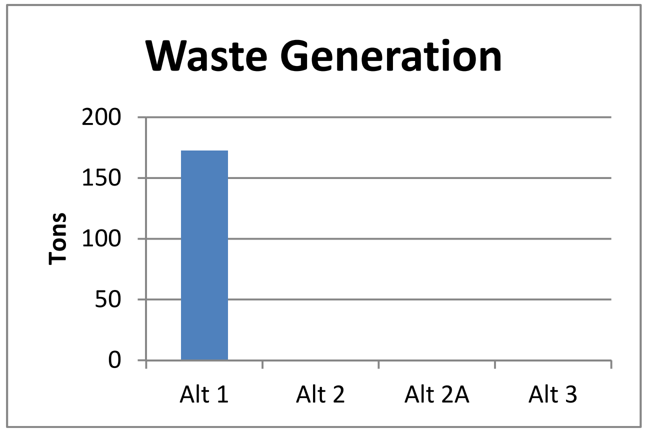
2.5 COMPARISON OF KEY FOOTPRINTS FOR ALTERNATIVES 1 THROUGH 3

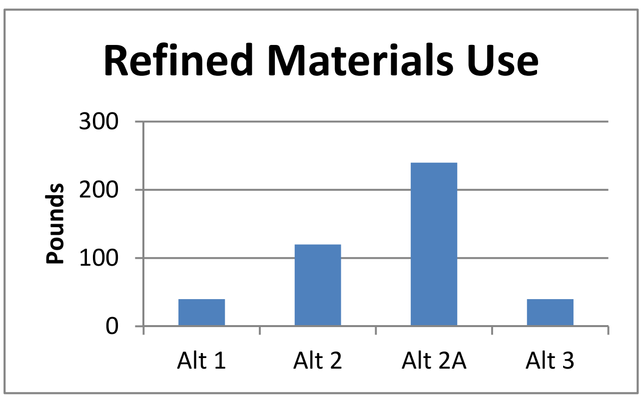
The charts below illustrate the values for some of the key footprints calculated for Alternatives 1 through 3. Note that all costs for these alternatives are assumed to be "up-front costs" because of the short time frame associated with the remedy. Also note that Alternative 2A represents the application of microbes in two applications rather than one (i.e., across two field seasons rather than one), and the footprints for Alternative 2A are twice the values of Alternative 2.

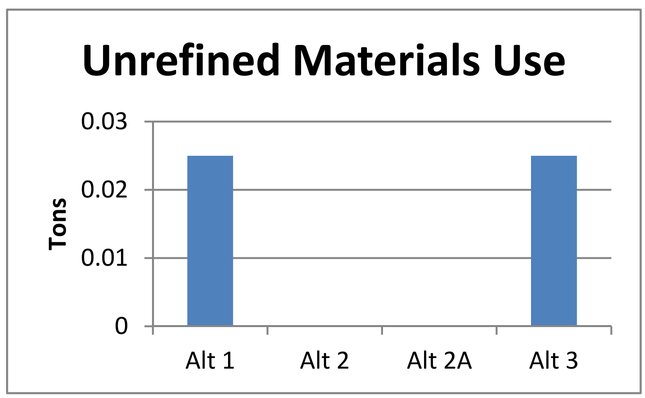

Total Energy Use
MMBtu
600
400
200
0
Alt 1
Alt 2
Alt 2A
Alt 3

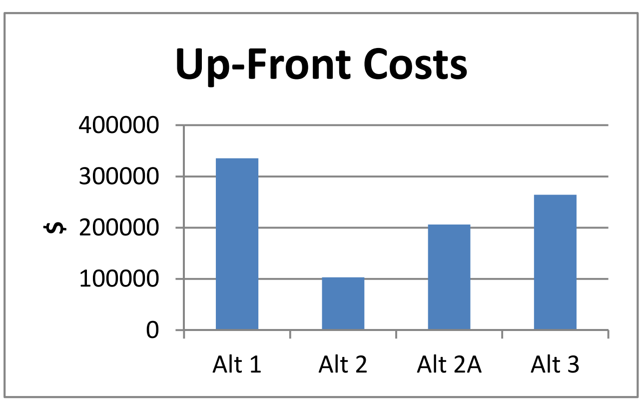

Total GHG Emissions
Metric Tons CO2e
50
40
30
20
10
0
Alt 1
Alt 2
Alt 2A
Alt 3


Criteria Pollutant Emissions
Metric Tons
200
150
100
50
0
Alt 1
Alt 2
Alt 2A
Alt 3


Waste Generation
Tons
200
150
100
50
0
Alt 1
Alt 2
Alt 2A
Alt 3


Refined Materials Use
Pounds
300
200
100
0
Alt 1
Alt 2
Alt 2A
Alt 3


Unrefined Materials Use
Tons
0.03
0.02
0.01
0
Alt 1
Alt 2
Alt 2A
Alt 3


Up-Front Costs
$
400000
300000
200000
100000
0
Alt 1
Alt 2
Alt 2A
Alt 3

2.6 OTHER QUALITATIVE CONSIDERATIONS

In addition to having the lowest cost and lowest footprints of the alternatives evaluated, Alternative 2 also requires fewer disturbances to the community. This is due to the fact that the number of days machinery will be operating will be substantially reduced, and that no waste will need to be transported through the community. In addition, field staff will need to be mobilized in this remote area for a shorter period of time. On the other hand, the Project Team indicates that there is not clear regulatory acceptance in Alaska for in-situ treatment with microbial products. For this reason, Alternative 2 is not actively being considered for the excavation work planned this summer at Akiachak. This GSR analysis does demonstrate that Alternative 2 has reduced environmental footprint (even if a second field season is required), and perhaps performing case studies at similar sites could promote regulatory acceptance.

3.0 GSR RECOMMENDATIONS

These are recommendations provided by the GSR Team for the consideration of the Project Team, and potentially other project stakeholders. These are not requirements, and implementation should ultimately be decided by the Project Team based on their concurrence regarding GSR benefits and/or other project-specific constraints.

GSR recommendations are summarized in the form of tracking tables, as follows (for this pilot project, some recommendations pertain to similar sites in Alaska rather than the specific site at Akiachak):

Table Number	Recommendation
3-1	3.1 - Assess the feasibility of use of an on-site biological treatment at sites in Alaska in place of excavation and off-site disposal
3-2	3.2 - Assess the feasibility of ex-situ thermal treatment in Bethel, AK in place of off-site disposal
3-3	3.3 - Use only alder wood treatment in place of GAC if it is sufficiently effective
3-4	3.4 - Include a section in the final report following remedial action that documents GSR considerations that were considered and implemented as part of the remedial action
3-5	3.5 - Submit appendices and lab reports for future deliverables electronically to save paper and perhaps shipping
3-6	3.6 - Collect rain water for on-site water use

The tracking table format allows the implementation status of the recommendation to be updated as the project progresses.

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Table 3-1
Tracking Table for Recommendation 3.1

<table>
<tr><td colspan="2">Recommendation:

3.1 - Assess the feasibility of use of an on-site biological treatment at sites in Alaska in place of excavation and off-site disposal</td><td>Current Date:
1/10/12
Date of Original Recommendation:
1/10/12</td></tr>
<tr><td colspan="3">Basis for Recommendation (Include discussion of cost impacts and value if appropriate):

On-site biological treatment with a microbial product would substantially reduce the environmental footprint as well as cost compared to excavation and off-site disposal. Due to a lack of clear regulatory acceptance, such treatment will not be used at the Akiachak FSA, but the feasibility of such treatment at sites with similar conditions should be evaluated so that it can potentially be used at other sites in Alaska in the future. This report includes a quantification of the changes in environmental footprint and cost when replacing an excavation and off-site disposal remedy with on-site biological treatment. This report also indicates favorable results regarding footprint reduction (including cost) for use of microbial products even if a second application in a subsequent field season is required.</td></tr>
<tr><td colspan="3">Resources Conserved:
☐ Hazardous air pollutants ☒ GHG emissions (CO2e) ☒ Energy ☐ Water ☒ Waste
☒ Criteria pollutants ☒ Safety/Community ☐ Materials ☐ Land-use</td></tr>
<tr><td>Qualitative Net Cost Impact Over 5 Years, No Discounting

☐ Cost Increase ☒ Cost Savings
☐ Cost Neutral ☐ N/A</td><td colspan="2">☐ Recommended action otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="3">Attachment(s) to report with footprint assumptions and calculations:

Appendix C-1(see Section 2.3.1 for discussion of contingency for a second application of microbial products in the subsequent field season).</td></tr>
<tr><td>Implementation Status:

☐ Fully
☐ Partially
☒ Not Yet
☐ Not Planned</td><td colspan="2">Explanation of Status:

This is a new recommendation for the Project Team to consider for future sites in Alaska.</td></tr>
</table>

Table 3-2
Tracking Table for Recommendation 3.2

<table>
<tr><td colspan="2">Recommendation:

3.2 - Assess the feasibility of ex-situ thermal treatment in Bethel, AK in place of off-site disposal</td><td>Current Date:
1/10/12

Date of Original Recommendation:
1/10/12</td></tr>
<tr><td colspan="3">Basis for Recommendation (Include discussion of cost impacts and value if appropriate):

This alternative, which eliminates transport of materials to Seattle and subsequent disposal in a landfill in Oregon, substantially reduces many of the key footprints including energy use, emissions of greenhouse gases, emission of criteria pollutants, waste disposal, and cost. The reductions are less than those that may be achieved with the in-situ bioremediation, but ex-situ thermal treatment may be a positive alternative if in-situ bioremediation is ultimately not acceptable to the regulators.</td></tr>
<tr><td colspan="3">Resources Conserved:
☐ Hazardous air pollutants ☒ GHG emissions (CO2e) ☒ Energy ☐ Water ☒ Waste
☒ Criteria pollutants ☐ Safety/Community ☐ Materials ☐ Land-use</td></tr>
<tr><td>Qualitative Net Cost Impact Over 5 Years, No Discounting

☐ Cost Increase ☒ Cost Savings
☐ Cost Neutral ☐ N/A</td><td colspan="2">☐ Recommended action otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="3">Attachment(s) to report with footprint assumptions and calculations:

Appendix C-2</td></tr>
<tr><td>Implementation Status:

☐ Fully
☐ Partially
☒ Not Yet
☐ Not Planned</td><td colspan="2">Explanation of Status:

This is a new recommendation for the Project Team to consider for future sites in Alaska.</td></tr>
</table>

Table 3-3
Tracking Table for Recommendation 3.3

<table>
<tr><td colspan="2">Recommendation:

3.3 - Use only alder wood treatment in place of GAC if it is sufficiently effective</td><td>Current Date:
1/10/12

Date of Original Recommendation:
1/10/12</td></tr>
<tr><td colspan="3">Basis for Recommendation (Include discussion of cost impacts and value if appropriate):

During the Step 5 call, the Project Team indicated that a pulp cellulose material made from crushed alder trees and produced in Alaska is used in lieu of a second GAC unit for treatment of water that may collect in the excavation. It was also indicated that the GAC unit is used at this site to address aesthetic issues with the discharge water, and that at other sites the cellulose material alone could potentially be used without the GAC treatment. Replacing GAC with the alder wood treatment would reduce refined materials use as well as cost, and the protectiveness and potential benefits of eliminating the GAC treatment should be evaluated. Note that no boxes in the “Resources Conserved” section below are checked, because this does not reduce the overall amount of materials, however the amount of refined materials would decrease and the alder is a recycled material, whereas the carbon may not be.</td></tr>
<tr><td colspan="3">Resources Conserved:
☐ Hazardous air pollutants ☐ GHG emissions (CO2e) ☐ Energy ☐ Water ☐ Waste
☐ Criteria pollutants ☐ Safety/Community ☐ Materials ☐ Land-use</td></tr>
<tr><td>Qualitative Net Cost Impact Over 5 Years, No Discounting

☐ Cost Increase ☒ Cost Savings
☐ Cost Neutral ☐ N/A</td><td colspan="2">☐ Recommended action otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="3">Attachment(s) to report with footprint assumptions and calculations:

This is a qualitative recommendation, and no detailed footprinting was performed.</td></tr>
<tr><td>Implementation Status:

☐ Fully
☐ Partially
☒ Not Yet
☐ Not Planned</td><td colspan="2">Explanation of Status:

This is a new recommendation for the Project Team to consider for future sites in Alaska.</td></tr>
</table>

Table 3-4
Tracking Table for Recommendation 3.4

<table>
<tr><td colspan="3">Recommendation:

3.4 - Include a section in the final report following remedial action that documents GSR considerations that were considered and implemented as part of the remedial action</td><td>Current Date:
1/10/12
Date of Original Recommendation:
1/10/12</td></tr>
<tr><td colspan="4">Basis for Recommendation (Include discussion of cost impacts and value if appropriate):

This was discussed during the Step 5 call. The Project Team has considered many GSR items, and these can be documented in the final report summarizing the remedy.</td></tr>
<tr><td colspan="4">Resources Conserved:
☐ Hazardous air pollutants ☐ GHG emissions (CO2e) ☐ Energy ☐ Water ☐ Waste
☐ Criteria pollutants ☐ Safety/Community ☐ Materials ☐ Land-use</td></tr>
<tr><td colspan="2">Qualitative Net Cost Impact Over 5 Years, No Discounting

☐ Cost Increase ☐ Cost Savings
☒ Cost Neutral ☐ N/A</td><td colspan="2">☐ Recommended action otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="4">Attachment(s) to report with footprint assumptions and calculations:

This is a qualitative recommendation, and no detailed footprinting was performed.</td></tr>
<tr><td>Implementation Status:

☐ Fully
☐ Partially
☒ Not Yet
☐ Not Planned</td><td colspan="3">Explanation of Status:

This is a new recommendation for the Project Team to consider when preparing the final report following remedial action.</td></tr>
</table>

Table 3-5
Tracking Table for Recommendation 3.5

<table>
<tr><td colspan="3" rowspan="2">Recommendation:

3.5 - Submit appendices and lab reports for future deliverables electronically to save paper and perhaps shipping</td><td>Current Date:
1/10/12</td></tr>
<tr><td>Date of Original Recommendation:
1/10/12</td></tr>
<tr><td colspan="4">Basis for Recommendation (Include discussion of cost impacts and value if appropriate):

Reports for this project are distributed in both hard copy and electronic forms. The army internal team receives electronic copies, but the regulators continue to request hard copies (the Project Team has asked about electronic copies several times). The GSR Team suggested that lab data and other appendices be distributed on disk instead of hard copies, and the Project Team agreed that this would be a good practice for other sites in Alaska, though lab reports for this site are fairly short.</td></tr>
<tr><td colspan="4">Resources Conserved:
☒ Hazardous air pollutants ☒ GHG emissions (CO2e) ☒ Energy ☐ Water ☒ Waste
☒ Criteria pollutants ☐ Safety/Community ☒ Materials ☐ Land-use</td></tr>
<tr><td colspan="2">Qualitative Net Cost Impact Over 5 Years, No Discounting

☐ Cost Increase ☒ Cost Savings
☐ Cost Neutral ☐ N/A</td><td colspan="2">☐ Recommended action otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="4">Attachment(s) to report with footprint assumptions and calculations:

This is a qualitative recommendation, and no detailed footprinting was performed.</td></tr>
<tr><td>Implementation Status:

☐ Fully
☐ Partially
☒ Not Yet
☐ Not Planned</td><td colspan="3">Explanation of Status:

This is a new recommendation for the Project Team to consider.</td></tr>
</table>

Table 3-6
Tracking Table for Recommendation 3.6

<table>
<tr><td colspan="2">Recommendation:

3.6 - Collect rain water for on-site water use</td><td>Current Date:
1/10/12
Date of Original Recommendation:
1/10/12</td></tr>
<tr><td colspan="3">Basis for Recommendation (Include discussion of cost impacts and value if appropriate):

Since local water supplies are constrained, it may be possible and beneficial to collect rain water to be used for construction (such as water that could be used for mixing the microbial product material in Alternative 2).</td></tr>
<tr><td colspan="3">Resources Conserved:
☐ Hazardous air pollutants ☐ GHG emissions (CO2e) ☐ Energy ☒ Water ☐ Waste
☐ Criteria pollutants ☐ Safety/Community ☐ Materials ☐ Land-use</td></tr>
<tr><td>Qualitative Net Cost Impact Over 5 Years, No Discounting

☐ Cost Increase ☐ Cost Savings
☐ Cost Neutral ☐ N/A</td><td colspan="2">☐ Recommended action otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="3">Attachment(s) to report with footprint assumptions and calculations:

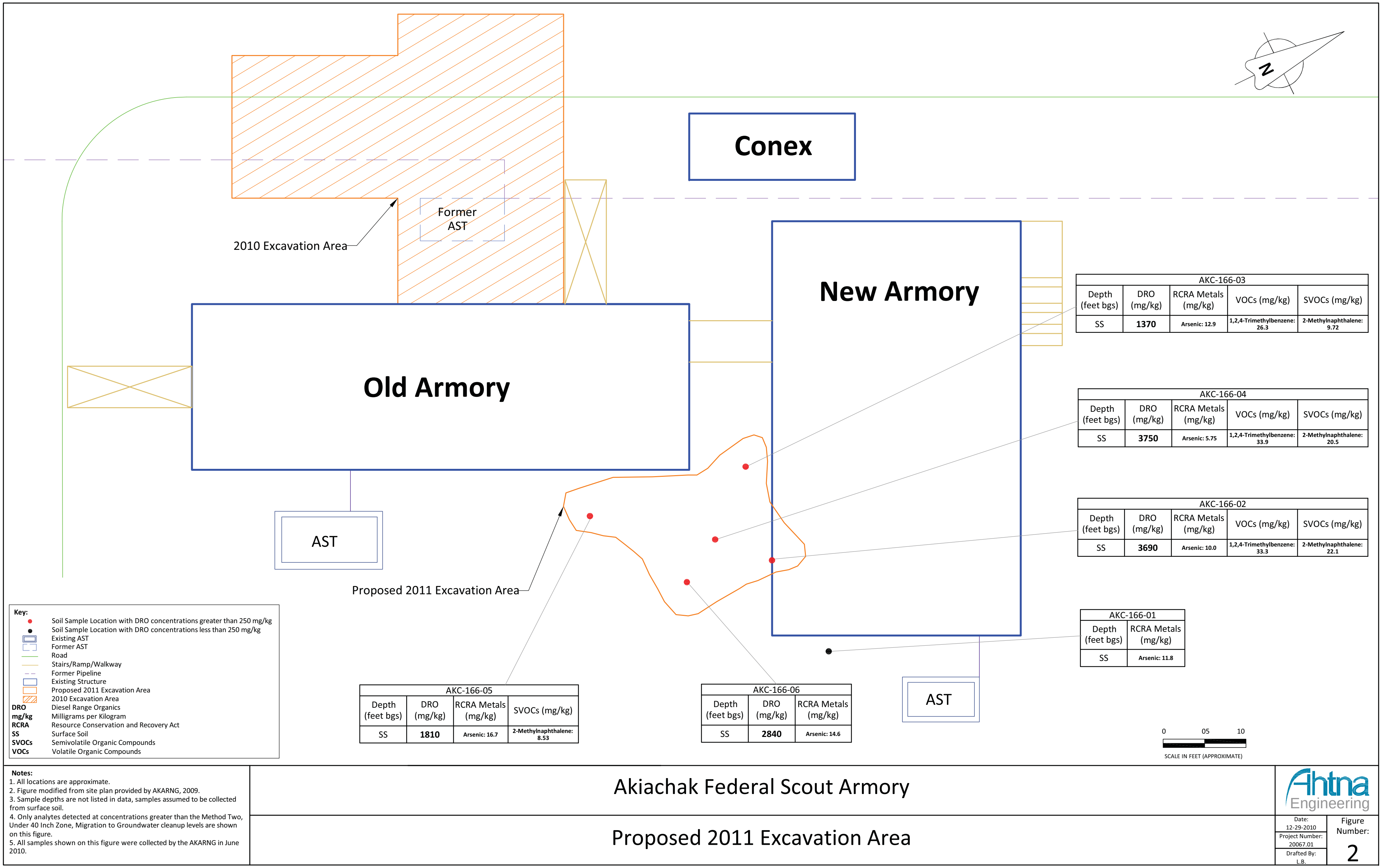
This is a qualitative recommendation, and no detailed footprinting was performed.</td></tr>
<tr><td>Implementation Status:

☐ Fully
☐ Partially
☒ Not Yet
☐ Not Planned</td><td colspan="2">Explanation of Status:

This is a new recommendation for the Project Team to consider for future sites in Alaska.</td></tr>
</table>

FIGURES

Figure 1-1. Site Layout and Proposed 2011 Excavation Area



AKC-166-03				
Depth (feet bgs)	DRO (mg/kg)	RCRA Metals (mg/kg)	VOCs (mg/kg)	SVOCs (mg/kg)
SS	**1370**	Arsenic: 12.9	1,2,4-Trimethylbenzene: 26.3	2-Methylnaphthalene: 9.72

AKC-166-04				
Depth (feet bgs)	DRO (mg/kg)	RCRA Metals (mg/kg)	VOCs (mg/kg)	SVOCs (mg/kg)
SS	**3750**	Arsenic: 5.75	1,2,4-Trimethylbenzene: 33.9	2-Methylnaphthalene: 20.5

AKC-166-02				
Depth (feet bgs)	DRO (mg/kg)	RCRA Metals (mg/kg)	VOCs (mg/kg)	SVOCs (mg/kg)
SS	**3690**	Arsenic: 10.0	1,2,4-Trimethylbenzene: 33.3	2-Methylnaphthalene: 22.1

AKC-166-01	
Depth (feet bgs)	RCRA Metals (mg/kg)
SS	Arsenic: 11.8

AKC-166-05			
Depth (feet bgs)	DRO (mg/kg)	RCRA Metals (mg/kg)	SVOCs (mg/kg)
SS	**1810**	Arsenic: 16.7	2-Methylnaphthalene: 8.53

AKC-166-06		
Depth (feet bgs)	DRO (mg/kg)	RCRA Metals (mg/kg)
SS	**2840**	Arsenic: 14.6

From Figure 2 of Final Remedial Action Plan Addendum (Ahtna Engineering, 3 January 2011)

APPENDIX A

Best Management Practice (BMP) Tables

BMP Category A: Planning

BMP A-1: Develop a culture of GSR within the Project Team and encourage GSR ideas from project staff	**Date:** 1/10/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☒ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Implementation of this BMP has largely been driven by the high cost for limited resources due to the remoteness of the area. For example, the high cost of fuel drives reductions in fuel use.*	

BMP A-2: Incorporate a section on GSR in project meetings, work plans, and reports	**Date:** 1/10/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☒ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☐ Waste ☒ Criteria pollutants ☒ Materials ☐ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *The Final Report after the remedy is performed could include a section that documents GSR considerations that were considered and implemented as part of the remedial action.*	

BMP Category A: Planning

BMP A-3: Identify and periodically update a list of key stakeholders and their concerns with respect to GSR considerations	**Date:** 1/10/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☒ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *There are some local community concerns regarding a preference that the Project Team use local equipment, materials, and labor. This generally aligns with economic goals, since it is cheaper to use local resources when they are available.*	

BMP A-4: Schedule activities for appropriate seasons and/or time of day to reduce delays caused by weather conditions and fuel needed for heating or cooling Examples: - Work at night in summer to avoid heat stress - Perform field activities in summer to take advantage of longer daylight	**Date:** 1/10/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☒ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *The window for remedial activities is already constrained by weather and temperature. Excavation needs to take place when the ground is firm, but not too hard to remove all of the contaminated soil. However, the permafrost in the area of excavation also needs to be preserved. Work is typically done at night or early morning when sunlight is less intense and a tarp is used to minimize melting of the permafrost.* *On-site work is also begun early in the morning to minimize disturbances to the community, where the greatest activity occurs in the afternoon.*	

BMP Category A: Planning

BMP A-5: Prepare, store, and distribute documents electronically	**Date:** 1/10/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☒ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☐ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Reports for this project are distributed in both hard copy and electronic forms. The army internal team receives electronic copies, but the regulators continue to request hard copies (the Project Team has asked about electronic copies several times). The GSR Team suggested that lab data and other appendices be distributed on disk instead of hard copies, and the Project Team agreed that this would be a good practice for other sites in Alaska, though lab reports for this site are fairly short.

BMP A-6: Utilize teleconferences rather than meetings when feasible	**Date:** 1/10/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Teleconferencing is utilized as much as possible due to the remoteness of the site. The field team can now be reached more easily due to increased cell phone coverage in the area (in the past the field staff has had to locate a land line).

BMP A-7: Incorporate green specifications into solicitations and contracts Examples: - Follow pertinent green procurement policies - Select hotel chains with "green" policies - Select laboratories that utilize renewable energy		**Date:** 1/10/12 ☒ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A	
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000	
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☒ Land-use	☐ BMP otherwise required? If checked, required by:	
Notes (including discussion of possible value of implementing the BMP): *GSR specifications are not included in the current contract with Ahtna, but they have seen and incorporated many GSR-related BMPs in their normal practices.*		

BMP A-8: Integrate schedules to allow for resource sharing and fewer days of field mobilization		**Date:** 1/10/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A	
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000	
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☐ Waste ☒ Criteria pollutants ☐ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:	
Notes (including discussion of possible value of implementing the BMP): *This is a standard practice at this site, where an effort is made to keep workers in the field for as few days as possible to maintain morale and safety given the remoteness. They also try to be efficient with activities so that there is little down-time.* *Quick turnaround lab samples prevent the need to re-mobilize. Excavation projects are divided into pieces so that the field team can continue with the excavation while waiting for sample results.*		

BMP A-9: Explore multiple site reuse options, including those that include some restriction of site reuse and related resource conservation	**Date:** 1/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP is not applicable for this site or others in Alaska, since it is required that they be remediated to unrestricted use.*	

BMP A-10: Conduct thorough review of project documents and historical records to minimize required scope of investigation Examples: - IRP projects: determine if there are previous aquifer tests that can be used for groundwater modeling rather than conducting new aquifer tests - MMRP projects: perform careful review of historic documents, aerial photographs, and other existing information to reduce the footprint of land that needs to be disturbed for thorough investigation and remediation - MMRP projects: use IRP sampling data to supplement and enhance the MMRP field program (if available)	**Date:** 1/10/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *A thorough historical review was conducted for site characterization, but a new unknown source of contamination caused the newest spill.*	

BMP Category B: Characterization and/or Remedy Approach

BMP B-1: Develop and routinely update a conceptual site model (CSM) to use as a basis for making remedial process decisions	**Date:** 1/10/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☒ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *A CSM has been developed, but frequent updates are not necessary due to the relative simplicity of the site.*	

BMP B-2: Perform frequent optimization evaluations to improve efficiency of current or planned actions and/or develop alternative remedial approaches that might shorten remedy duration or otherwise improve the net environmental benefit of the remedy	**Date:** 1/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP is not applicable for this project, since it does not involve an active, ongoing system.*	

BMP Category B: Characterization and/or Remedy Approach

<table>
<tr><td colspan="3">BMP B-3: Use appropriate characterization or remedy approach based on site conditions
Examples:
- Consider in-situ and passive remedy options that offer adequate protectiveness
- Consider in-situ bioremediation if conditions are already anaerobic and constituents are conducive to reductive dechlorination
- Compare source removal versus in-situ and ex-situ remedial options
- Consider different technologies for impacted areas with higher and lower concentrations
- Use realistic times to remedy closeout (i.e., estimations through modeling) rather than assumed remedy timeframes (e.g., 30 years), which is often used for evaluation of FS alternatives
- MMRP projects: evaluate man-portable DGM instruments versus vehicle-towed array (VTA) instruments and inclusion of detector-aided reconnaissance (DAR)</td><td>Date: 1/10/12

☒ Applicable
☒ Evaluated
☒ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☒ Economic ☒ Social</td><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="2">Resources Conserved:
☒ Hazardous air pollutants ☒ Energy ☒ Waste
☒ Criteria pollutants ☒ Materials ☒ Safety/Community
☒ GHG emissions (CO2e) ☒ Water ☒ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

The approach to screening as described in the work plan is what makes most sense for this site. Hand augers will be used to collect samples since impacts are shallow. A PID and quick turnaround samples will be used rather than a mobile lab to determine the extent of contamination and excavation.</td></tr>
</table>

<table>
<tr><td colspan="3">BMP B-4: Establish decision points to trigger a change from one technology to another or from one remedy alternative to another
Examples:
- Change vapor treatment from thermal oxidation to granular activated carbon (GAC) media based on flow rates and concentrations
- Remove a treatment polishing step if influent to that step already meets discharge criteria
- Move to Monitored Natural Attenuation (MNA) if specific concentration thresholds in groundwater are met</td><td>Date: 1/10/12

☐ Applicable
☐ Evaluated
☐ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social</td><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="2">Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

This BMP is not applicable for this project.</td></tr>
</table>

BMP Category B: Characterization and/or Remedy Approach

BMP B-5: Focus sampling efforts to meet objectives of the specific remedial phase (e.g., sampling during O&M should be focused on evaluating remedy performance and not on thorough plume characterization) Examples: - Eliminate sampling parameters as appropriate - Reduce sampling frequency as appropriate - Reduce sample locations as appropriate - Enhance monitoring program as appropriate - MMRP projects: consider Incremental Sampling Methodology (ISM) versus discrete sampling for MC characterization	**Date:** 1/10/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

A multi-incremental sampling approach is used at sites where conditions allow in order to reduce sample volumes. This method is approved by the regulators for this site. It is determined in the field if conditions are appropriated for this sampling method, and whether incremental or discrete sampling will provide the best results.

BMP B-6: Consider real-time measurements and dynamic work plans to reduce mobilizations and improve effectiveness of investigation efforts Examples: - Field test kits (e.g., test kits for sulfate) - Field screening instruments (e.g., x-ray fluorescence for lead or photoionization detectors for volatile organics) - Drive point sensor technologies (e.g., membrane interface probe or "MIP") - Visual staining or odor - Establish excavation extent based on real-time data collected as excavation proceeds and use GPS to accurately delineate excavation areas - MMRP projects: use GPS and/or the same equipment that was used for detection to confirm anomaly signatures prior to excavating - MMRP projects: consider incorporating field screening methods (e.g., X-ray fluorescence, EXPRAY and explosives test kits, as appropriate or applicable) into the field program to refine sampling locations and reduce the quantities of samples submitted for off-site laboratory analysis	**Date:** 1/10/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

As mentioned previously, quick turnaround samples are used for field screening. Conditions can change with the seasonal thaw of permafrost, so delineation prior to excavation doesn't make sense. 3 to 4 batches of samples will likely be sent to the lab to avoid unnecessary excavation.

BMP Category B: Characterization and/or Remedy Approach

BMP B-7: Consider use of existing site structures/infrastructure or mobilization of temporary structures versus new construction

Examples:

- Buildings (e.g., for treatment building or field office)
- Concrete slabs or foundations
- Wells
- Existing excavations for storm water control

Date: 1/10/12

☒ Applicable

☒ Evaluated

☒ Practical

Implemented?
("N/A" if "Practical" not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☒ Economic ☒ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☒ Hazardous air pollutants ☒ Energy ☒ Waste
☒ Criteria pollutants ☒ Materials ☒ Safety/Community
☒ GHG emissions (CO2e) ☒ Water ☒ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

At some sites an old armory that is no longer needed will be given to the community for use. If the building needs to be moved as part of the remedy, they will move it to where the community wants it.

BMP B-8: Establish project-specific decision points to limit extent of remediation

Examples:

- Project-specific cleanup levels based on a site-specific risk assessment (coordinated with risk assessment experts) rather than generic cleanup levels, if it results in lower footprints for key parameters and is acceptable to all stakeholders
- MMRP projects: dig stopping rules and anomaly prioritization/detection criteria to minimize false positives

Date: 1/10/12

☐ Applicable

☐ Evaluated

☐ Practical

Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
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☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

The state of Alaska requires remediation to a certain cleanup standard, so site-specific cleanup levels could not be used for this project. A hydrocarbon risk calculator has recently been approved and could be used for future projects, but cleanup will still need to be to unrestricted use.

BMP Category B: Characterization and/or Remedy Approach

BMP B-9: Consider leaving in place structures whose removal is not necessary (i.e., foundations, underground pillars, etc.)	**Date:** 1/10/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☐ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

The Old and New Armories will be left in place as long as contamination does not extend under either building.

BMP Category C: Energy/Emissions – Transportation

<table>
<tr><td colspan="3">BMP C-1: Reduce the number of trips for personnel
Examples:
- Encourage carpooling
- Use telemetry systems and webcams to remotely transmit data directly to project offices to avoid trips</td><td>Date: 1/10/12
☒ Applicable
☒ Evaluated
☒ Practical</td></tr>
<tr><td>Implemented?
("N/A" if "Practical" not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
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If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

As previously discussed, efforts are made to minimize the number of trips to the site. Teleconferencing is used whenever possible, and quick turnaround samples are used so that re-mobilization can be avoided. The staff for this site is generally based in Anchorage, but there are efforts to use local hires when feasible, and for this project there is a local with HAZWOPER training that can be utilized to avoid travel by others.</td></tr>
</table>

<table>
<tr><td colspan="3">BMP C-2: Reduce the number of trips and/or volume for transported materials, equipment, or waste
Examples:
- Transfer full loads by consolidating shipments from vendors and/or shipments to disposal sites (also share shipments with neighbors if feasible)
- Purchase more concentrated chemicals to reduce transportation weight and/or volume</td><td>Date: 1/10/12
☒ Applicable
☒ Evaluated
☒ Practical</td></tr>
<tr><td>Implemented?
("N/A" if "Practical" not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
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<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
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☒ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

Excavated soil will be shipped on pre-established transport, so it will not be significantly increasing fuel use. The barge that will be used makes periodic trips to Akiachak to bring supplies and take away any waste. The barge does not typically take out a large amount of waste, so the excavated soil would not be displacing other waste and creating the need for an additional barge trip.

The field screening methods and dynamic work plan for excavation will minimize the volume of soil that will need to be transported.</td></tr>
</table>

BMP Category C: Energy/Emissions – Transportation

BMP C-3: Reduce trip lengths Examples: - Dispose of waste at closest appropriate facility - Purchase materials, equipment, and services from local vendors - Use locally produced supplies - Select most efficient transportation route	**Date:** 1/10/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☐ Waste ☒ Criteria pollutants ☐ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

All staff is Anchorage-based. Efforts are made to use local employees as sub-contractors to the extent possible and use local equipment, materials, and supplies when feasible.

BMP C-4: Use alternate fuels or other options for transportation when possible Examples: - Compressed natural gas - Biodiesel blends - Ethanol blends - Hybrid and/or electric - Rail lines versus trucks - Use a fuel efficient passenger car rather than a pickup truck if task allows	**Date:** 1/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

The majority of the transport is not directly controlled by the Project Team. Once the excavated soil reaches Seattle, it is transported by truck to a Union Pacific railroad station approximately 5 miles from the Seattle port, and from there it is transported via rail line directly to the landfill. This same transport route is used to bring other waste to this landfill, so a special trip is not required for the excavated waste.

BMP Category D: Energy/Emissions – Equipment Use

<table>
<tr><td colspan="3">BMP D-1: Consider and implement approaches to minimize engine idle times</td><td>Date: 1/10/12
☒ Applicable
☒ Evaluated
☒ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
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<tr><td colspan="2">Resources Conserved:
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☒ Criteria pollutants ☐ Materials ☐ Safety/Community
☒ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

This BMP was already implemented during the last excavation and will be for the planned excavation. High fuel cost and limited availability are the primary drivers behind implementation of this BMP.</td></tr>
</table>

<table>
<tr><td colspan="3">BMP D-2: Ensure peak operating efficiency of equipment to reduce energy use and emissions
Examples:
- Perform preventative maintenance and operate equipment per manufacturer instructions
- Perform retrofits involving low-maintenance multi-stage filters for cleaner engine exhaust
- Use synthetic oil to extend operating life (and reduce waste oil)
- Purchase newer equipment with reduced emissions</td><td>Date: 1/10/12
☐ Applicable
☐ Evaluated
☐ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
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<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
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☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

This BMP is not applicable for this project, since the Project Team is limited by what equipment is locally available. Any benefits that would be gained by bringing in newer equipment would be outweighed by emissions from shipping the equipment to the site.</td></tr>
</table>

BMP Category D: Energy/Emissions – Equipment Use

BMP D-3: Use alternate fuel options for equipment when possible

Examples:

- Compressed natural gas
- Biodiesel
- Ethanol blends
- Ultra-low sulfur diesel, wherever available (and as required by engines with PM traps)

Date: 1/10/12

☐ Applicable

☐ Evaluated

☐ Practical

Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

This BMP is not applicable for this project due to limited fuel availability in this area.

BMP D-4: Select appropriate equipment and/or power source for the job

Examples:

- Avoid using large excavators for small earthmoving projects
- Use direct push methods when possible to reduce drilling duration
- Compare potential use of electricity versus battery versus generator

Date: 1/10/12

☒ Applicable

☒ Evaluated

☐ Practical

Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☐ Waste ☒ Criteria pollutants ☐ Materials ☐ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

In this case the equipment is appropriately sized for the area that needs to be excavated, but this is not always true for other sites. The Project Team is typically forced to use what is locally available, since the cost and emissions for transport to the site would outweigh any benefits of having more appropriately sized equipment.

BMP Category D: Energy/Emissions – Equipment Use

BMP D-5: Use variable frequency drives on motors (e.g., pumps, blowers), or replace oversized motors with properly sized motors	**Date:** 1/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP is not applicable for this project.*	

BMP D-6: Identify options for generating renewable energy for direct use in the remedy and/or for alternate use at or near the project site Examples: - Solar, wind, landfill gas (microturbines), combined heat and power, geothermal heat exchange - Applications for remote areas such as solar pumps or solar flares (if demand is not continuous, the need for a battery backup may be avoided) - Generate power or heat exchange from water to be discharged	**Date:** 1/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP is not applicable for this project.*	

BMP Category D: Energy/Emissions – Equipment Use

BMP D-7: Consider purchase of renewable energy certificates to offset emissions from the remedial activities	**Date:** 1/10/12 ☒ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☒ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☒ Energy ☐ Waste ☒ Criteria pollutants ☐ Materials ☐ Safety/Community ☒ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Implementation of this BMP is constrained by the need to conduct remedial activities at the lowest cost to do what is technically necessary.*	

BMP D-8: Design/modify housing required for above-ground treatment components for energy-efficiency Examples: - Passive lighting - Compact fluorescent lighting (CFL) or light-emitting diode (LD) lighting - Timers and/or motion control sensors for lighting - Shading - Minimize heating and cooling needs (building size, insulation, etc.)	**Date:** 1/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP is not applicable for this remedy, since there is no above-ground treatment component.*	

BMP Category D: Energy/Emissions – Equipment Use

BMP D-9: For remedies that involve groundwater or air extraction, optimize extraction to reduce flow rates (potentially beneficial with respect to energy use, materials usage, water resources, waste disposal, etc.)	**Date:** 1/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP is not applicable for this project.*	

BMP D-10: Consider pulsing for extraction of water or air to maximize mass removal per unit of time or energy, by extracting higher concentrations	**Date:** 1/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP is not applicable for this project.*	

BMP Category D: Energy/Emissions – Equipment Use

<table>
<tr><td colspan="3">BMP D-11: Run electrical equipment during times of lower electric demand if possible (this does not reduce energy use but could lower cost and also can lower stress on the energy grid during periods of peak demand)</td><td>Date: 1/10/12
☐ Applicable
☐ Evaluated
☐ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social</td><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="2">Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

This BMP is not applicable for this project.</td></tr>
</table>

BMP Category E: Materials & Off-Site Services

BMP E-1: Use materials that are made from recycled materials Examples: - Steel - Asphalt - Plastics - Concrete	**Date:** 1/10/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☒ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☒ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

A pulp cellulose material made from crushed alder trees and produced in Alaska is used as a backup or polishing step for the GAC.

Sand is mined from a sand pit for this site for borrow material, but the Project Team may need to look at other options for other sites. This could include using thermally treated soil or excavating to a desired final grade rather than backfilling.

BMP E-2: Optimize the amount of materials used Examples: - Experiment with different material amounts/doses - Consider alternate materials - Use timers or feedback loops and process controls for dosing - MMRP projects: minimize quantities of donor explosives for MEC destruction	**Date:** 1/10/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☒ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

The main materials used will be GAC and sand, and these tend to be self-optimizing due to cost and availability.

BMP Category E: Materials & Off-Site Services

BMP E-3: Utilize less refined materials when feasible

Examples:

- Limestone instead of sodium hydroxide for pH adjustment
- Native fill instead of select fill

Date: 1/10/12

☒ Applicable

☒ Evaluated

☒ Practical

Implemented? (“N/A” if “Practical” not checked) ☐ Fully ☒ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☒ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

The pulp cellulose material (discussed in BMP E-1) is less refined than the GAC.

BMP E-4: Identify opportunities for using by-products or “waste” materials from local sources in place of refined chemicals or materials

Examples:

- Cheese whey, molasses, compost, or off-spec food products for inducing anaerobic conditions
- Crushed concrete for use as fill
- Concrete from coal combustion byproducts

Date: 1/10/12

☒ Applicable

☒ Evaluated

☒ Practical

Implemented? (“N/A” if “Practical” not checked) ☐ Fully ☒ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☒ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

The pulp cellulose material made from crushed alder trees would replace a second GAC unit at Akiachak, but GAC would still be used following bag filtration to address aesthetic issues with the discharged water. At other sites, the cellulose material alone could be used.

BMP Category E: Materials & Off-Site Services

BMP E-5: Reduce demand on Publicly Owned Treatment Works (POTWs) Examples: - Discharge treated water to groundwater or to surface water rather than POTW - Minimize amount of water requiring treatment	**Date:** 1/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP is not applicable for this project.*	

BMP Category F: Water Resource Use

BMP F-1: Minimize water consumption Examples: - Sensors to turn off water when not needed - Low flow fittings - Minimize water needs for irrigation (landscape choices, use of mats and mulch)	**Date:** 1/10/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☒ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Very little local water is available (must purchase by the gallon at the local washeria). As a result, water use is highly constrained.*	

BMP F-2: Preferentially use less refined water resources when feasible Examples: - Use extracted groundwater instead of potable water for chemical blending - Capture and store rain/storm water for future use - Employ rumble grates with a closed-loop gray-water washing system	**Date:** 1/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Rain water could be collected for minor on-site water uses. This would be particularly useful if on-site biological treatment were selected, since water is needed for diluting microbe additions to the soil.*	

BMP Category F: Water Resource Use

BMP F-3: Use extracted and treated water for beneficial purposes Examples: - Irrigation - Potable water - Industrial process water	**Date:** 1/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

This BMP is not applicable for this project.

BMP F-4: Promote groundwater recharge Examples: - Recharge extracted and treated water when beneficial uses of the water are not identified and reinjection is practical - Minimize site area covered by impervious surfaces to reduce runoff and maximize infiltration (unless such capping is a specific component of the remedial action)	**Date:** 1/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

This BMP is not applicable for this project.

BMP Category F: Water Resource Use

BMP F-5: Maintain water quality by preventing nutrient loading to surface water or groundwater Examples: - Use phosphate-free detergents instead of organic solvents or acids to decontaminate sampling equipment (if not required for some contaminants)	**Date:** 1/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *There is no surface water in the vicinity of the excavation (the closest surface water body is ~1/4 mile from the site). Decon for equipment involves a dry brush scraping and sometimes a small amount of water and soap (not a recordable amount).*	

BMP Category G: Waste Generation, Disposal, and Recycling

BMP G-1: Minimize drill cuttings and all other investigation derived waste (including personal protection equipment) Examples: - Direct push or sonic drilling to reduce drill cuttings - Low-flow sampling or passive diffusion bags (if applicable) to reduce purge water - When possible place drill cuttings on-site rather than off-site disposal	**Date:** 1/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP is not applicable for this project.*	

BMP G-2: Segregate excavated soil in pre-planned staging areas so that "clean" material can be deposited on-site and/or reused rather than transported for off-site disposal	**Date:** 1/10/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☒ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP is already implemented at the site, and is described in the work plan. Overburden to the contaminated zone is removed and sampled, and if it is clean it is used for backfill. A separate pile is made for excavated material that appears clean, and this too is sampled and used for backfill if clean.*	

BMP Category G: Waste Generation, Disposal, and Recycling

BMP G-3: Consider on-site treatment and re-use of soil instead of off-site disposal
Examples:
- Land farming
- Above ground soil vapor extraction (SVE)

Date: 1/10/12

☒ Applicable
☒ Evaluated
☐ Practical

Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☒ Economic ☒ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☒ Hazardous air pollutants ☒ Energy ☒ Waste
☒ Criteria pollutants ☐ Materials ☒ Safety/Community
☒ GHG emissions (CO2e) ☐ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

This BMP was initially suggested by the GSR Team (using microbe addition as an example), but cannot be applied at this site because this type of in-situ treatment has not been clearly approved by regulators in Alaska. This may be a possibility for other sites if successful remediation using addition of microbes has been demonstrated in an area with similar weather and temperature conditions.

BMP G-4: Minimize need to transport and dispose hazardous waste
Examples:
- Consider delisting listed hazardous waste if waste is not characteristically hazardous waste
- Segregate hazardous waste and non-hazardous waste

Date: 1/10/12

☐ Applicable
☐ Evaluated
☐ Practical

Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

This site does not and will not generate hazardous waste

BMP Category G: Waste Generation, Disposal, and Recycling

BMP G-5: When possible avoid/minimize use of hazardous/toxic materials that may require special handling or disposal

Examples:

- Cleaning solutions
- Pesticides
- Disposable batteries (use rechargeable batteries)
- MMRP projects: minimize Chemical Agent Contaminated Media (CACM) at RCWM sites.

Date: 1/10/12

☐ Applicable
☐ Evaluated
☐ Practical

Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

This BMP is not applicable for this project, since no hazardous or toxic materials will be used.

BMP G-6: Recycle or reuse materials rather than disposing of them

Examples:

- Cardboard
- Plastics
- Concrete
- Asphalt
- Steel and other metals
- Recovered oil/product
- Mulch/compost
- MMRP projects - recycle recovered Material Documented as Safe (MDAS) after inspection and certification that the remnants are free of explosive hazards

Date: 1/10/12

☒ Applicable
☒ Evaluated
☐ Practical

Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☐ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☒ Hazardous air pollutants ☒ Energy ☒ Waste
☒ Criteria pollutants ☒ Materials ☐ Safety/Community
☒ GHG emissions (CO2e) ☐ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

On-site treatment would allow the reuse of the contaminated soil rather than disposal in a landfill, but may not be feasible for the reasons discussed above.

BMP Category H: Land Use, Ecosystems, and Cultural Resources

BMP H-1: Minimize erosion and soil transport to surface water bodies Examples: - Quickly restore any vegetated areas disrupted by equipment or vehicles - Institute appropriate erosion controls during excavation such as silt fencing	**Date:** 1/10/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *For seeding over the excavated area, a geomembrane will be used to hold the soil while the seeds take root.*	

BMP H-2: Minimize disturbances to land Examples: - Establish well-defined traffic patterns for on-site activities to minimize disturbed areas - Consider non-intrusive investigation techniques (e.g., geophysical methods) to identify items like USTs and buried drums	**Date:** 1/10/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Equipment mats will be used to reduce disturbance to vegetation.* *Temporary fencing will be used to control traffic through the site. This will prevent excess traffic over seeded areas so that the new vegetation can take hold.*	

BMP H-3: Preserve/restore ecosystems to the extent possible Examples: - Limit the removal of trees and vegetation - Attempt to transplant disturbed shrubs and small trees to other locations - Use native species for re-vegetation - Retrieve dead trees during excavation and later reposition them as habitat snags - Select and place suitably sized and typed stones into water beds and banks - Undercut surface water banks in ways that mirror natural conditions - Cut back rather than remove trees, bushes, vegetation	**Date:** 1/10/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Since this area is all tundra, there will be no trees, shrubs, or other large vegetation to be restored. Any disturbed areas will be re-seeded with native grass.*	

BMP H-4: Minimize drawdown of the water table in sensitive areas such as wetlands or areas subject to subsidence	**Date:** 1/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP is not applicable for this project.*	

BMP H-5: Construct wells and other remedial process infrastructure (piping, buildings, etc.) to minimize restrictions to anticipated future use of the site	**Date:** 1/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP is not applicable for this project, since no new infrastructure will be left on-site after the excavation is complete.*	

BMP H-6: Preserve/restore cultural resources to the extent possible Examples: - Protected lands such as wildlife refuges, national parks, and wilderness areas - Culturally sensitive sites such as cemeteries, native burials, and archaeological finds - Buildings or land parcels with historical significance	**Date:** 1/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP is not applicable for the site at Akiachak, but it could apply to some of the other sites that contain archeological finds. For these sites, a monitoring system will be developed.*	

BMP H-7: Document sensitive ecological and cultural resources prior to initiating actions that might diminish or destroy those resources Examples: - Photodocument conditions prior to clearing brush - MMRP projects: photodocument conditions prior to BIP			**Date:** 1/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A		
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000		
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use		☐ BMP otherwise required? If checked, required by:	
Notes (including discussion of possible value of implementing the BMP): *This BMP is not applicable for the site at Akiachak, which involves a very small excavation, but it could apply to some of the other sites. For these sites, the Project Team has a process for evaluating potential impacts to nearby resources.*			

BMP Category I: Safety and Community

BMP I-1: Minimize and mitigate noise, light and odor disturbance during all phases of the remedial process, to the extent practicable	**Date:** 1/10/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☒ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

There have been some complaints from the community that remedial actions disturb the normal activities of the village. In response, the Project Team tries to minimize the time spent at the site. Since village activity typically starts late in the day, work at the site is begun early to minimize disturbances.

BMP I-2: Minimize dust during construction activities by spraying water or techniques such as laying biodegradable mats, tarps, or materials (already in EM385-1-1)	**Date:** 1/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☒ BMP otherwise required? If checked, required by: *EM385-1-1*

Notes (including discussion of possible value of implementing the BMP):

Dust control is not typically an issue in this area. During the excavation in summer 2010, frequent rain provided ample dust control. The Project Team anticipates similar conditions during the planned excavation in summer 2011.

BMP Category I: Safety and Community

BMP I-3: Select transportation routes for trucks and heavy equipment that minimize impacts to residential areas to maximize safety and minimize noise and other aesthetic impacts	**Date:** 1/10/12 ☒ Applicable ☒ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☒ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Alternatives for transport routes are limited, and the route to the borrow pit does go by houses. During these trips, a spotter is always used to watch for people, particularly small children. The excavator will be used for these trips; there are two dump trucks in the village with larger capacities (which would result in fewer trips), but neither works. Many of the other sites have boardwalks, which would not support large dump trucks.*	

BMP I-4: Minimize drawdown of the water table in areas that could impact production rates at supply wells and/or irrigation wells	**Date:** 1/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP is not applicable for this project.*	

BMP I-5: Minimize amount of time that heavy machinery is needed to enhance safety		**Date:** 1/10/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A	
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000	
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☒ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:	
Notes (including discussion of possible value of implementing the BMP): *Heavy machinery use will be self-optimizing due to the high cost and limited availability of fuel in this area.*		

BMP I-6: Minimize handling of dangerous chemicals by selecting alternate chemicals and/or engineering to minimize contact with chemicals (for MMRP projects, there is enhanced risk related to explosion potential and exposure to chemical agents (CA) and agent breakdown products (ABP) associated with RCWM responses)		**Date:** 1/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A	
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000	
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:	
Notes (including discussion of possible value of implementing the BMP): *This BMP is not applicable for this project.*		

BMP Category I: Safety and Community

<table>
<tr><td colspan="3">BMP I-7: Contribute to local economy when possible
Examples:
- Consider leasing local office space
- Purchase or lease equipment from local vendors
- Hire workers from local community</td><td>Date: 1/10/12
☒ Applicable
☒ Evaluated
☒ Practical</td></tr>
<tr><td>Implemented?
("N/A" if "Practical" not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☒ Social</td><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="2">Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☒ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

Remedial activity at Akiachak and other sites in Alaska typically contributes to the local economy in a number of ways. Most projects rent local equipment owned by the community and use local workers as sub-contractors to the extent possible. While the field team at Akiachak stayed at the armory during the summer 2010 excavation, at other sites the field team often stays at the school (for a donation) or at apartments owned by the village. In addition, old armories are often donated for community use.</td></tr>
</table>

BMP Category J: Other Site-Specific BMPs

BMP J-1:			**Date:**
			☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A		
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000		
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use		☐ BMP otherwise required? If checked, required by:	
Notes (including discussion of possible value of implementing the BMP):			

BMP J-2:			**Date:**
			☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A		
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000		
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use		☐ BMP otherwise required? If checked, required by:	
Notes (including discussion of possible value of implementing the BMP):			

APPENDIX B

Assumptions for SiteWise Input and Other Calculations
Akiachak FSA Pilot GSR Evaluation
Alternative 1 – Excavation and Off-Site Disposal (Baseline Option)

Appendix B
Assumptions for SiteWise Input and Other Calculations
Akiachak FSA Pilot GSR Evaluation
Excavation and Off-Site Disposal (Baseline)

Baseline Remedy – Excavation and Off-Site Disposal – SiteWise "Alternative 1" Directory

The scope of work, as outlined in the Final RAP Addendum, includes the following actions:

- Mobilize personnel, equipment, and materials to the Akiachak FSA;
- Locate and excavate DRO-contaminated soil on the east side of the Old Armory;
- Field screen excavated soil, as applicable;
- Collect confirmation soil samples from excavated areas for off-site laboratory analysis;
- Treat water that collects in excavation with GAC polished by alder wood, discharge treated water to ground, and disposed of GAC and alder in landfill in Anchorage;
- Backfill, re-grade, and revegetate areas disturbed by project activities;
- Arrange for the off-site transportation and disposal of the excavated DRO-contaminated soil;
- Demobilize personnel, equipment, and materials from the Akiachak FSA;

The notes pertaining to SiteWise input are organized by the following sections of SiteWise input:

- Mobilization and Demobilization of Personnel, Equipment, and Materials – Uses "Remedial Action Investigation" tab of SiteWise input for SiteWise "Alternative 1"

- Excavation and Sampling – Uses "Remedial Action Construction" tab of SiteWise input for SiteWise "Alternative 1"

- Site Restoration – Uses "Remedial Action Operations" tab of SiteWise input for SiteWise "Alternative 1"

- Transport of Excavated Material to Off-Site Disposal – Uses "Longterm Monitoring" tab of SiteWise input for "SiteWise "Alternative 1"

For each section of SiteWise, all the sections are listed, with pertinent information added only for those sections of the input sheet where data were added.

Baseline – Overview

Other calculations done outside of SiteWise are then presented. These include the following:

- % of total energy from renewable resources
- Hazardous air pollutants
- Refined material use
- Unrefined material use
- Tons of non-hazardous waste
- Risks to on-site works and from transportation
- Heavy truck trips through residential areas

Additional tables are attached which show how SiteWise outputs were split into "direct" and "indirect" energy use and greenhouse gas emissions. For definitions of direct and indirect energy use and emissions, please refer to section 2.2.2 of the evaluation report.

A cost sheet is also attached. Cost estimates are based on a cost estimate for remedial actions provided by Ahtna. This information was provided to the GSR Team via email attachment from Jennifer Nutt on 14 April, 2011. Information regarding the cost calculations is as follows:

Item	Estimated Cost
Remedial Action Plan	$9,746
Remedial Action Fieldwork (Labor)	$97,101
Equipment	$25,600
Materials	$8,921
Laboratory	$5,003
Contaminated Soil Transportation	$127,979
Contaminated Soil Disposal	$20,873
Travel and ODCs	$36,014
Remedial Action Report	$4,296
Total Cost	**$335,533**

- The capital cost for the remedy is estimated at $335,533.

- There is assumed to be no annual O&M cost for this remedy, since the planned action will remediate to unrestricted use.

- Capital costs are assumed to occur in year 0, and annual costs are assumed to occur in years 1 to 30.

- To determine net present value (NPV), a 3 percent discount rate is applied to future costs (since there are no annual costs, the discount rate does not impact the calculation of NPV).

- NPV is calculated by discounting future costs to present-day dollars using the following equation:

$$PV = \frac{FV}{(1+i)^n} = C \times FV$$

PV is the present value
FV is the value in year "n" (i.e., future value)
i is the discount rate
C is the discount factor, which equals $1/(1+i)^n$

Baseline – Mobilization and Demobilization of Personnel, Equipment, and Materials

<u>Scope of Work</u>

- Ahtna field team will include an equipment operator, laborer, and either the project geologist or field scientist (3 people total). Assume the laborer is local (i.e., the other 2 people flying from Anchorage). Transport of personnel by commercial air will be from Anchorage to Akiachak.
- Heavy equipment will include one 100 class excavator and one loader for filling super sacks and backfill. Both are owned by the village, and will be driven a short distance to and from the site (< 1 mile).
- All other field equipment will be transported to and from Akiachak by either barge or air transportation. Assumed to be negligible for footprinting.

Baseline – Mobilization and Demobilization of Personnel, Equipment, and Materials

<u>SiteWise Input – Input into "Remedial Action Investigation" tab of SiteWise "Alternative 1"</u>

- Material Production
    - Well Materials
    - Treatment Chemicals & Materials
    - GAC
    - Construction Materials
    - Well Decommissioning
- Transportation
    - Personnel Transportation – Road
    - Personnel Transportation – Air
        - Trip 1 – Assume 2 individuals on round-trip flight from Anchorage to Akiachak. Distance is ~400 miles one-way = 800 miles round-trip
    - Personnel Transportation – Rail
    - Equipment Transportation – Road
        - Trip 1 – Assume equipment transported ~2 miles round trip to and from site. Assume ~12 tons for the excavator.
        - Trip 2 – Assume equipment transported ~2 miles round trip to and from site. Assume ~12 tons for the loader.
    - Equipment Transportation – Air
    - Equipment Transportation – Rail
    - Equipment Transportation – Water

- Equipment Use
    - Earthwork
    - Drilling
    - Pump operation
    - Diesel and Gasoline Pumps
    - Blower, Compressor, Mixer, and Other Equipment
    - Generators
    - Agricultural Equipment
    - Capping Equipment
    - Mixing Equipment

- Residual Handling
    - Residue Disposal/Recycling
    - Landfill Operations
    - Thermal/Catalytic Oxidizers
    - Water Consumption
    - Landfill Methane Emissions

- Other Known On-Site Activities
    - CO_2 Emissions

Baseline – Excavation and Sampling

Scope of Work

- Use excavator to remove ~115 cy of contaminated soil and fill super sacks
  - Project Team indicated 5 to 8 hours per day (assume 6.5 average) for the first 1.5 weeks and 2 hours per day for the second 1.5 weeks.
- Assume samples sent to lab via courier in 3-4 batches. There are 2 daily scheduled flights round trip from Akiachak to Anchorage (so the samples will not be creating a separate trip).
- Less than 1 mile of transport will be required between the site and the plane, and less than 1 mile from the airport in Anchorage to the lab. Assume negligible for footprinting.
- GAC filtration for water collected in excavation. Assume ~40 lbs (one 5-gallon bucket, quantity estimated by Project Team) transported to and from site by air. Assume transport to Anchorage by air and subsequent transport to landfill by truck.
- Polishing using alder wood cellulose material. Assume ~50 lbs (quantity estimated by Project Team) transported to and from site by air. Assume transport to Anchorage by air and subsequent transport to landfill by truck.

Baseline – Excavation and Sampling

<u>SiteWise Input – Input into "Remedial Action Construction" tab in SiteWise "Alternative 1"</u>

- Material Production
  - Well Materials
  - Treatment Chemicals & Materials
    - Treatment 1 – Mulch used to represent 50 lbs alder wood material for polishing step.
  - GAC
    - Treatment 1 – 40 lbs of GAC for water treatment.
  - Construction Materials
  - Well Decommissioning

- Transportation
  - Personnel Transportation – Road
  - Personnel Transportation – Air
  - Personnel Transportation – Rail
  - Equipment Transportation – Road
  - Equipment Transportation – Air
    - Trip 1 – Coolers for samples. Assume 4 trips for coolers weighing 50 lbs (0.025 tons) per trip. Assume 400 miles one way.
    - Trip 2 – GAC for water treatment. Assume 400 miles one way to deliver GAC to site and 400 miles to landfill disposal. Assume 40 lbs (0.02 tons).
    - Trip 3 – Alder wood for polishing step. Assume 400 miles one way to deliver GAC to site and 400 miles to landfill disposal. Assume 50 lbs (0.025 tons).
    - Trip 4 – Assume 1 trip for shipping coolers with bottles to the site from Anchorage. Assume 10 lbs per cooler * 4 coolers = 40 lbs.
  - Equipment Transportation – Rail
  - Equipment Transportation – Water

- Equipment Use
  - Earthwork
    - Equipment 1 – 1 excavator; assume operation for 10 days for 6.5 hours per day and 10 days for 2 hours per day (10*6.5 + 10*2 = 85 hours of operation). The Project Team has indicated the approximate size of the excavator and the hours of operation. The productivity rates in the SiteWise lookup table for excavator use do not agree with the estimated hours of operation provided by the Project Team, so the productivity rate for the appropriately sized excavator in the SiteWise lookup table was updated to be consistent with their estimate.
  - Drilling
  - Pump operation
    - Pump 1 – 1 bladder or trash type pump for GAC unit. Assume 10 gpm, 20 ft of head, 10 hours of operation total.
  - Diesel and Gasoline Pumps
  - Blower, Compressor, Mixer, and Other Equipment
  - Generators
  - Agricultural Equipment
  - Capping Equipment
  - Mixing Equipment

Baseline – Excavation and Sampling

- Residual Handling
    - Residue Disposal/Recycling
        - Material Residue – GAC and alder wood disposed of in landfill near Anchorage. Assume 20 mile transport via truck from airport. No empty return trip, because it is assumed that this is part of a scheduled shipment. Weight = 40 + 50 = 90 lbs = 0.045 tons.
    - Landfill Operations
    - Thermal/Catalytic Oxidizers
    - Water Consumption
    - Landfill Methane Emissions

- Other Known On-Site Activities

Baseline – Site Restoration

<u>*Scope of Work*</u>

- Backfilling excavated area and re-grading
    - Analytically-confirmed clean overburden will be used for backfill to the extent possible. The remaining backfill will come from a borrow pit within ~1/4 mile of the site, and the loader will be used to haul this material to the site. Assume ~115 cy to fill excavated area.
    - The loader will also be used to move super sacks containing 115 cy of excavated soil to the barge landing area (~1/2 to 1/4 mile from the site).
    - The Project Team indicated 6-8 hours of loader operation per day for the last 1.5 weeks of remedial action for the tasks listed above.
- Areas disturbed by project activities will be revegetated. The disturbed area will be fertilized and an Alaskan grass seed mixture will be spread over areas disturbed by project activities. This is not footprinted.

Baseline – Site Restoration

<u>SiteWise Input – Input into "Remedial Action Operations" tab in SiteWise "Alternative 1"</u>

- Material Production
    - Well Materials
    - Treatment Chemicals & Materials
    - GAC
    - Construction Materials
    - Well Decommissioning

- Transportation
    - Personnel Transportation – Road
    - Personnel Transportation – Air
    - Personnel Transportation – Rail
    - Equipment Transportation – Road
    - Equipment Transportation – Air
    - Equipment Transportation – Rail
    - Equipment Transportation – Water

- Equipment Use
    - Earthwork
        - Equipment 1 – Loader; assume operation for 10 days for 7 hours per day (70 hours of operation). The Project Team has indicated the approximate size of the loader and the hours of operation. The productivity rates in the SiteWise lookup table for loader use do not agree with the estimated hours of operation provided by the Project Team, so the productivity rate for the appropriately sized loader in the SiteWise lookup table was updated to be consistent with their estimate.
    - Drilling
    - Pump operation
    - Diesel and Gasoline Pumps
    - Blower, Compressor, Mixer, and Other Equipment
    - Generators
    - Agricultural Equipment
    - Capping Equipment
    - Mixing Equipment

- Residual Handling
    - Residue Disposal/Recycling
    - Landfill Operations
    - Thermal/Catalytic Oxidizers
    - Water Consumption
    - Landfill Methane Emissions

- Other Known On-Site Activities

Baseline – Transport of Excavated Material to Off-Site Disposal

<u>*Scope of Work*</u>

- Transport from the excavation area to the barge landing area (½ - ¼ miles). The loader will be used to transport super sacks. Loader hours of operation accounted for in the "Site Restoration" section above.
- Transport via barge from Akiachak to Seattle, WA (~3000 miles).
  - The excavated material will likely account for ~½ of the barge's load from Akiachak to Bethel (~25 miles).
  - It will likely take up ~1/8 of the barge load from Bethel to Seattle (~2900 miles).
- Transport via truck from the shipyard in Seattle to railroad station ~5 miles away.
- Transport via rail ~250-300 miles to Arlington, OR.
- Note: all transport is "piggybacking" on transport that would already have taken place. Therefore, the footprint will be calculated based only on the added fuel use due to the additional weight of the excavated material.

Baseline – Transport of Excavated Material to Off-Site Disposal

<u>SiteWise Input – Input into "Longterm Monitoring" tab in SiteWise "Alternative 1"</u>

- Material Production
    - Well Materials
    - Treatment Chemicals & Materials
    - GAC
    - Construction Materials
    - Well Decommissioning

- Transportation
    - Personnel Transportation – Road
    - Personnel Transportation – Air
    - Personnel Transportation – Rail
    - Equipment Transportation – Road
        - Trip 1 – Transport of excavated material via truck from Seattle shipyard to rail station (~5 miles). Assume 3000 lbs/cy of soil * 115 cy = 345,000 lbs = 172.5 tons. SiteWise only allows up to 40 tons for road transport, so assume 5 trips with 34.5 tons each, so total miles is 25 (5 trips * 5 miles).
    - Equipment Transportation – Air
    - Equipment Transportation – Rail
        - Trip 1 – Transport of excavated material via rail from Seattle rail station to landfill in Arlington, OR (~300 miles). Assume 3000 lbs/cy of soil * 115 cy = 345,000 lbs = 172.5 tons.
    - Equipment Transportation – Water
        - Trip 1 – Transport of excavated material via barge from Akiachak to Bethel to Seattle (~3000 miles total). Assume 3000 lbs/cy of soil * 115 cy = 345,000 lbs = 172.5 tons.

- Equipment Use
    - Earthwork
    - Drilling
    - Pump operation
    - Diesel and Gasoline Pumps
    - Blower, Compressor, Mixer, and Other Equipment
    - Generators
    - Agricultural Equipment
    - Capping Equipment
    - Mixing Equipment

- Residual Handling
    - Residue Disposal/Recycling
    - Landfill Operations
    - Thermal/Catalytic Oxidizers
    - Water Consumption – Purge water from sampling is negligible
    - Landfill Methane Emissions

- Other Known On-Site Activities

Other Supporting Calculations
Akiachak FSA Pilot GSR Evaluation
Excavation and Off-Site Disposal (Baseline)

% of Total Energy Usage from Renewable Resources

- None identified. Perhaps a negligible amount associated with electricity generation used for pump. According to eGRID (http://cfpub.epa.gov/egridweb/view_srl.cfm), the percentage of electricity from renewable sources for region AKMS is ~66% (most of which is hydropower), but the amount from renewable at this site is still negligible because electricity use represents such a small portion (<0.01%) of the overall energy use for this remedy, which is dominated by transportation and equipment use.

Hazardous Air Pollutants

- None identified

.

Refined Materials Use

- 40 lbs GAC (assume 100% virgin)

- Other refined materials assumed to have negligible contribution to total materials use

Unrefined Materials Use

- 50 lbs alder mulch (assumed to be recycled)

Tons of Non-Hazardous Waste

- 172.5 tons for excavated soil
- 0.045 tons for GAC plus alder mulch

Risks to On-Site Workers and from Transportation

- Refer to "Total" tab of the "Summary.xlsx" spreadsheet
- For transportation related risks, sum injuries and fatalities for all transportation activities
- Add total risk form transportation and non-transportation, and then subtract the transportation sums previously calculated, to get non-transportation

Heavy Truck Trips through Residential Areas

- Not quantified, but many given the proximity of the village and the many trips expected for the loader between the borrow pit and the excavation.

Ahtna Engineering

ALASKA ARMY NATIONAL GUARD
COMPLIANCE CLEANUP 2009

Schedule of Values - Akiachak Federal Scout Armory (FSA) Cost Estimate for Remedial Actions at New Area of Concern (AOC)

Akiachak FSA		
Remedial Action Plan	$	9,746
Remedial Action Fieldwork (Labor)	$	97,101
Equipment	$	25,600
Materials	$	8,921
Laboratory	$	5,003
Contaminated Soil Transportation	$	127,979
Contaminated Soil Disposal	$	20,873
Travel and ODCs	$	36,014
Remedial Action Report	$	4,296
Costs Estimate for Remedial Actions at New AOC	**$**	**335,532**

Project: GSR Pilot for Akiachak FSA
Option or Alternative: Baseline Option (Excavation and Off-Site Disposal)
Current Date: 1/10/2012

year	up-front cost	annual cost		present value of cost each year		cumulative cash flow	
		(no discounting)		3.0%		no discounting	3.0%
0	$335,533	$0		$335,533		$335,533	$335,533
1	$0	$0		$0		$335,533	$335,533
2	$0	$0		$0		$335,533	$335,533
3	$0	$0		$0		$335,533	$335,533
4	$0	$0		$0		$335,533	$335,533
5	$0	$0		$0		$335,533	$335,533
6	$0	$0		$0		$335,533	$335,533
7	$0	$0		$0		$335,533	$335,533
8	$0	$0		$0		$335,533	$335,533
9	$0	$0		$0		$335,533	$335,533
10	$0	$0		$0		$335,533	$335,533
11	$0	$0		$0		$335,533	$335,533
12	$0	$0		$0		$335,533	$335,533
13	$0	$0		$0		$335,533	$335,533
14	$0	$0		$0		$335,533	$335,533
15	$0	$0		$0		$335,533	$335,533
16	$0	$0		$0		$335,533	$335,533
17	$0	$0		$0		$335,533	$335,533
18	$0	$0		$0		$335,533	$335,533
19	$0	$0		$0		$335,533	$335,533
20	$0	$0		$0		$335,533	$335,533
21	$0	$0		$0		$335,533	$335,533
22	$0	$0		$0		$335,533	$335,533
23	$0	$0		$0		$335,533	$335,533
24	$0	$0		$0		$335,533	$335,533
25	$0	$0		$0		$335,533	$335,533
26	$0	$0		$0		$335,533	$335,533
27	$0	$0		$0		$335,533	$335,533
28	$0	$0		$0		$335,533	$335,533
29	$0	$0		$0		$335,533	$335,533
30	$0	$0		$0		$335,533	$335,533

Net Present Value (NPV)-> $335,533

*positive dollar value is a "cost", negative dollar value is a "savings"

GSR Team Calculations to Split Energy Results from SiteWise into "Direct" and "Indirect"
Excavation and Off-Site Disposal (Baseline)

phase	Reported by SiteWise		Assigned by GSR Team from SiteWise Output			Added by GSR Team	Total Calculated by GSR Team
			Scope 1 (direct)	Scope 2 (indirect)	Scope 3 (indirect)	Scope 3 (indirect)	
	activity	energy used (MMBTU)	energy used (MMBTU)	energy used (MMBTU)	energy used (MMBTU)	energy used (MMBTU)	
Mobilization and Demobilization of Personnel, Equipment, and Materials (remedial investigation tab)	Consumables	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	5.22	0.00	0.00	5.22	1.25	6.47
	Transportation-Equipment	0.08	0.00	0.00	0.08	0.02	0.10
	Equipment Use and Misc	0.00	0.00	0.00	0.00	0.00	0.00
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-Total	5.30	0.00	0.00	5.30	1.27	6.57
Excavation and Sampling (remedial action construction tab)	Consumables	2.20	0.00	0.00	2.20	0.00	2.20
	Transportation-Personnel	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Equipment	0.81	0.00	0.00	0.81	0.19	1.00
	Equipment Use and Misc	93.34	93.33	0.01	0.00	22.40	115.74
	Residual Handling	0.35	0.00	0.00	0.35	0.08	0.43
	Sub-Total	96.69	93.33	0.01	3.35	22.68	119.37
Site Restoration (remedial action operation tab)	Consumables	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Equipment	0.00	0.00	0.00	0.00	0.00	0.00
	Equipment Use and Misc	12.64	12.64	0.00	0.00	3.03	15.68
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-Total	12.64	12.64	0.00	0.00	3.03	15.68
Transport of Excavated Material to Off-Site Disposal (longterm monitoring tab)	Consumables	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Equipment	284.47	0.00	0.00	284.47	68.27	352.75
	Equipment Use and Misc	0.00	0.00	0.00	0.00	0.00	0.00
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-Total	284.47	0.00	0.00	284.47	68.27	352.75
total		399.11	105.98	0.01	293.13	95.26	494.37

Note: For energy use related to fuel use for transportation or on-site equipment use, SiteWise reports energy use associated with combustion only. The added Scope 3 energy use for these activities take into account upstream energy use (i.e. energy required for extraction, refining, etc.). The added energy is based on multipliers used in the GREET software, version 1.8d.1, which in this case equates to multiplying energy used in fuel combustion by 0.24 to calculate the upstream energy use.

Electricity use reported by SiteWise in units of kWh is "Direct Scope 1", meaning it is energy consumed at the location of the project. However, energy use associated with electricity reported by SiteWise in units of MMBtu is a life-cycle value which also includes a factor to account for energy used elsewhere required to generate the electricity ("Indirect Scope 2"). Here, 33% of the life-cycle value reported by SiteWise is considered to be "Scope 1" on-site energy use, and 67% is considered to be "Scope 2" energy used in electricity generation.

GSR Team Calculations to Split GHG Results from SiteWise into "Direct" and "Indirect"
Excavation and Off-Site Disposal (Baseline)

	Reported by SiteWise		Assigned by GSR Team from SiteWise Output			Added by GSR Team	
			Scope 1 (direct)	Scope 2 (indirect)	Scope 3 (indirect)	Scope 3 (indirect)	
phase	activity	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	Total Calculated by GSR Team
Mobilization and Demobilization of Personnel, Equipment, and Materials (remedial investigation tab)	Consumables	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	0.45	0.00	0.00	0.45	0.11	0.56
	Transportation-Equipment	0.01	0.00	0.00	0.01	0.001	0.01
	Equipment Use and Misc	0.00	0.00	0.00	0.00	0.00	0.00
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-Total	0.45	0.00	0.00	0.45	0.11	0.56
Excavation and Sampling (remedial action construction tab)	Consumables	0.12	0.00	0.00	0.12	0.00	0.12
	Transportation-Personnel	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Equipment	0.13	0.00	0.00	0.13	0.03	0.16
	Equipment Use and Misc	5.33	5.33	0.0002	0.00	1.28	6.61
	Residual Handling	0.02	0.00	0.00	0.02	0.01	0.03
	Sub-Total	5.60	5.33	0.00	0.28	1.32	6.92
Site Restoration (remedial action operation tab)	Consumables	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Equipment	0.00	0.00	0.00	0.00	0.00	0.00
	Equipment Use and Misc	0.86	0.86	0.00	0.00	0.21	1.06
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-Total	0.86	0.86	0.00	0.00	0.21	1.06
Transport of Excavated Material to Off-Site Disposal (longterm monitoring tab)	Consumables	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Equipment	26.89	0.00	0.00	26.89	6.45	33.34
	Equipment Use and Misc	0.00	0.00	0.00	0.00	0.00	0.00
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-Total	26.89	0.00	0.00	26.89	6.45	33.34
total		33.80	6.18	0.0002	27.62	8.08	41.88

Note: For GHG emissions related to fuel use for transportation or on-site equipment use, SiteWise reports emissions associated with combustion only. The added Scope 3 emissions for these activities take into account upstream emissions (i.e. emissions related to extraction, refining, etc.). The added emissions factor is based on multipliers used in the GREET software, version 1.8d.1, which in this case equates to multiplying emission from fuel combustion by 0.24 to calculate the upstream emissions.

CO2e reported by SiteWise for electricity use is all associated with generation of the electricity ("Indirect Scope 2").

APPENDIX C

Supporting Information and/or Calculations for Footprinting of Other Alternatives

APPENDIX C-1

Alternative 2 – On-Site Biological Treatment

Appendix C-1
Assumptions for SiteWise Input and Other Calculations
Akiachak FSA Pilot GSR Evaluation
On-Site Biological Treatment (Alternative 2)

Alternative 2 – On-Site Biological Treatment – SiteWise "Alternative 2" Directory

Assumptions for this alternative include the following:

- The application of a microbial product for in-situ remediation would likely take approximately one day. There are several options for application of such products, but for the purposes of this evaluation it is assumed that this would include alternating between spraying the product onto the soil and using an excavator to till the contaminated soil in order to distribute the product effectively. At no time will there be an open excavation area for any extended period, so the need for GAC treatment of water that might collect in such an excavation is eliminated.
- Based on discussion with a vendor, this remedy would require approximately 15 gallons of microbial product diluted with water to a 6% solution, which would require approximately 235 gallons of water. The Project Team has indicated that since water resources are limited in this area, water would need to be purchased by the gallon from a local source.
- It is assumed that the number of workers required for applying the on-site treatment will remain approximately the same as in the baseline option. As with the product application, several options for delineating the contaminated area exist. For this evaluation, assume that samples will be collected for lateral and horizontal delineation just prior to treatment and sent to the lab for quick-turnaround. In all, it is assumed that this remedial action will require approximately one week of field work (one mobilization).
- Another sampling trip would be required the next season to confirm the remedy was successful. It is assumed for this site that this sampling can be performed by the local subcontractor using a hand-auger. It will require shipping two coolers to and from the site.

The notes pertaining to SiteWise input are organized by the following sections of SiteWise input:

- Mobilization and Demobilization of Personnel, Equipment, and Materials – Uses "Remedial Action Investigation" tab of SiteWise input for SiteWise "Alternative 2"
- Tilling and Treatment – Uses "Remedial Action Construction" tab of SiteWise input for SiteWise "Alternative 2"
- Site Restoration – Uses "Remedial Action Operations" tab of SiteWise input for SiteWise "Alternative 2" (none for this alternative)
- Confirmatory Sampling – Uses "Longterm Monitoring" tab of SiteWise input for "SiteWise "Alternative 2"

For each section of SiteWise, all the sections are listed, with pertinent information added only for those sections of the input sheet where data were added.

Alternative 2 – Overview

Other calculations done outside of SiteWise are then presented. These include the following:

- % of total energy from renewable resources
- Hazardous air pollutants
- Refined material use
- Unrefined material use
- Tons of non-hazardous waste
- Risks to on-site works and from transportation
- Heavy truck trips through residential areas

Additional tables are attached which show how SiteWise outputs were split into "direct" and "indirect" energy use and greenhouse gas emissions. For definitions of direct and indirect energy use and emissions, please refer to section 2.2.2 of the evaluation report.

A cost sheet is also attached. Cost estimates are partially based on a cost estimate for remedial actions provided by Ahtna, (i.e. modified from the baseline cost estimates provided by Ahtna to account for differences in this alternative). The changes to the Ahtna cost estimate are as follows:

Item	Baseline Cost	Alternative 2 Cost	Explanation for Estimated Change in Cost from Baseline to Alternative 2
Remedial Action Plan	$9,746	$9,746	No anticipated change
Remedial Action Fieldwork (Labor)	$97,101	$32,367	Reduced fieldwork from 3 weeks to 1 week (assume labor cut by a factor 3)
Equipment	$25,600	$4,267	Reduced fieldwork from 3 weeks to 1 week and reduced heavy equipment use from excavator and loader to excavator only (assume equipment cut by a factor of 6, based on a factor of 3 for time and a factor of 2 for eliminating 1 of the pieces of equipment, which is the loader)
Materials	$8,921	$8,921	Some reduction in materials use is assumed, but with the additional cost of microbial product, water, and other materials, it is assumed that this cost will be approximately equal
Laboratory	$5,003	$7,505	Number of samples multiplied by 1.5 to account for confirmatory sampling the following year
Contaminated Soil Transportation	$127,979	$0	All soil will remain on-site
Contaminated Soil Disposal	$20,873	$0	All soil will remain on-site, disposal costs for used GAC and alder wood assumed to be eliminated
Travel and ODCs	$36,014	$36,014	No anticipated change
Remedial Action Report	$4,296	$4,296	No anticipated change

Alternative 2 – Overview

Item	Baseline Cost	Alternative 2 Cost	Explanation for Estimated Change in Cost from Baseline to Alternative 2
Total Cost	**$335,533**	**$103,115**	

Information regarding the cost calculations is as follows:

- The capital cost for this alternative is $103,115. We are lumping a confirmatory sample for effectiveness of the remediation the following season in with the other costs as a "capital cost".
- There is assumed to be no annual O&M cost for this remedy, since the planned action will remediate to unrestricted use.
- Capital costs are assumed to occur in year 0, and annual costs are assumed to occur in years 1 to 30.
- To determine net present value (NPV), a 3 percent discount rate is applied to future costs (since there are no annual costs, the discount rate does not impact the calculation of NPV).
- NPV is calculated by discounting future costs to present-day dollars using the following equation:

$$PV = \frac{FV}{(1+i)^n} = C \times FV$$

PV is the present value
FV is the value in year "n" (i.e., future value)
i is the discount rate
C is the discount factor, which equals $1/(1+i)^n$

Alternative 2 – Mobilization and Demobilization of Personnel, Equipment, and Materials

<u>*Scope of Work*</u>

- Ahtna field team will include an equipment operator, laborer, and either the project geologist or field scientist (3 people total). Assume the laborer is local (i.e., other 2 people flying from Anchorage). Transport of personnel by commercial air will be from Anchorage to Akiachak.
- Heavy equipment will include one 100 class excavator owned by the village, which will be driven a short distance to and from the site (< 1 mile).
- Transport 15 gallons (three 5-gallon pails) of microbial product from Anchorage to Akiachak. There are 2 daily scheduled flights round trip from Akiachak to Anchorage (so the microbial product will not be creating a separate trip).
- All other field equipment will be transported to and from Akiachak by either barge or air transportation. Assumed to be negligible for footprinting.

Alternative 2 – Mobilization and Demobilization of Personnel, Equipment, and Materials

SiteWise Input – Input into "Remedial Action Investigation" tab of SiteWise "Alternative 2"

- Material Production
    - Well Materials
    - Treatment Chemicals & Materials
    - GAC
    - Construction Materials
    - Well Decommissioning
- Transportation
    - Personnel Transportation – Road
    - Personnel Transportation – Air
        - Trip 1 – Assume 2 individuals on round-trip flight from Anchorage to Akiachak. Distance is ~400 miles one-way = 800 miles round-trip
    - Personnel Transportation – Rail
    - Equipment Transportation – Road
        - Trip 1 – Assume equipment transported ~2 miles round trip to and from site. Assume ~12 tons for the excavator.
    - Equipment Transportation – Air
        - Trip 1 – Assume microbial product transported ~400 miles from Anchorage to Akiachak. 15 gallons * ~8 lbs/gallon = 120 lbs = 0.06 tons
    - Equipment Transportation – Rail
    - Equipment Transportation – Water

- Equipment Use
    - Earthwork
    - Drilling
    - Pump operation
    - Diesel and Gasoline Pumps
    - Blower, Compressor, Mixer, and Other Equipment
    - Generators
    - Agricultural Equipment
    - Capping Equipment
    - Mixing Equipment

- Residual Handling
    - Residue Disposal/Recycling
    - Landfill Operations
    - Thermal/Catalytic Oxidizers
    - Water Consumption
    - Landfill Methane Emissions

- Other Known On-Site Activities
    - CO_2 Emissions

Alternative 2 – Tilling and Treatment

Scope of Work

- Use excavator to till ~115 cy of contaminated soil during microbial product application.
  - Assume one day (8 hours) of excavator operation for taking samples to send to lab, and assume one day of excavator operation later in the week for tilling.
- Spray 6% solution (15 gallons of microbial product to 235 gallons of water) over excavated soil.
- Assume samples sent to lab via courier in one batch. There are 2 daily scheduled flights round trip from Akiachak to Anchorage (so the samples will not be creating a separate trip).
- Less than 1 mile of transport will be required between the site and the plane, and less than 1 mile from the airport in Anchorage to the lab. Assume negligible for footprinting.

Alternative 2 – Tilling and Treatment

<u>SiteWise Input – Input into "Remedial Action Construction" tab in SiteWise "Alternative 2"</u>

- Material Production
    - Well Materials
    - Treatment Chemicals & Materials
        - Treatment 1 – Vegetable oil selected in SiteWise to represent microbial product. 15 gallons * 8 lbs/gallon = 120 lbs
    - GAC
    - Construction Materials
    - Well Decommissioning

- Transportation
    - Personnel Transportation – Road
    - Personnel Transportation – Air
    - Personnel Transportation – Rail
    - Equipment Transportation – Road
    - Equipment Transportation – Air
        - Trip 1 – Coolers for samples. Assume 1 trip for 4 coolers weighing 50 lbs (0.025 tons) each. Assume 400 miles one way.
        - Trip 2 – Assume 1 trip for shipping coolers with bottles to the site from Anchorage. Assume 10 lbs per cooler * 4 coolers = 40 lbs.
    - Equipment Transportation – Rail
    - Equipment Transportation – Water

- Equipment Use
    - Earthwork
        - Equipment 1 – 1 excavator; assume operation for 2 day (16 hours). The productivity rates in the SiteWise lookup table for excavator use do not agree with the estimated hours of operation, so the productivity rate for the appropriately sized excavator in the SiteWise lookup table was updated to be consistent with our estimated hours of operation.
    - Drilling
    - Pump operation
    - Diesel and Gasoline Pumps
    - Blower, Compressor, Mixer, and Other Equipment
    - Generators
    - Agricultural Equipment
    - Capping Equipment
    - Mixing Equipment

- Residual Handling
    - Residue Disposal/Recycling
    - Landfill Operations
    - Thermal/Catalytic Oxidizers
    - Water Consumption
    - Landfill Methane Emissions

- Other Known On-Site Activities
    - Water consumption – 235 gallons of water for microbial product solution

Alternative 2 – Site Restoration

Scope of Work

- Areas disturbed by project activities will be revegetated. The disturbed area will be fertilized and an Alaskan grass seed mixture will be spread over areas disturbed by project activities. This is not footprinted.

Alternative 2 – Site Restoration

<u>*SiteWise Input – Input into "Remedial Action Operations" tab in SiteWise "Alternative 2"*</u>

- Material Production
  - Well Materials
  - Treatment Chemicals & Materials
  - GAC
  - Construction Materials
  - Well Decommissioning

- Transportation
  - Personnel Transportation – Road
  - Personnel Transportation – Air
  - Personnel Transportation – Rail
  - Equipment Transportation – Road
  - Equipment Transportation – Air
  - Equipment Transportation – Rail
  - Equipment Transportation – Water

- Equipment Use
  - Earthwork
  - Drilling
  - Pump operation
  - Diesel and Gasoline Pumps
  - Blower, Compressor, Mixer, and Other Equipment
  - Generators
  - Agricultural Equipment
  - Capping Equipment
  - Mixing Equipment

- Residual Handling
  - Residue Disposal/Recycling
  - Landfill Operations
  - Thermal/Catalytic Oxidizers
  - Water Consumption
  - Landfill Methane Emissions

- Other Known On-Site Activities

Alternative 2 – Confirmatory Sampling

Scope of Work

- Assume local contractor (in Akiachak) will take confirmatory samples the following season using a hand-auger.
- Assume samples sent to lab via courier in 1 additional batch during the summer following the application of microbial product. There are 2 daily scheduled flights round trip from Akiachak to Anchorage (so the samples will not be creating a separate trip).
- Less than 1 mile of transport will be required between the site and the plane, and less than 1 mile from the airport in Anchorage to the lab. Assume negligible for footprinting.

Alternative 2 – Confirmatory Sampling

SiteWise Input – Input into "Longterm Monitoring" tab in SiteWise "Alternative 2"

- Material Production
  - Well Materials
  - Treatment Chemicals & Materials
  - GAC
  - Construction Materials
  - Well Decommissioning

- Transportation
  - Personnel Transportation – Road
  - Personnel Transportation – Air
  - Personnel Transportation – Rail
  - Equipment Transportation – Road
  - Equipment Transportation – Air
    - Trip 1 – Coolers for samples. Assume 1 trips for 2 coolers weighing 50 lbs (0.025 tons) each. Assume 400 miles one way.
    - Trip 2 – Assume 1 trip for shipping coolers with bottles to the site from Anchorage. Assume 10 lbs per cooler * 4 coolers = 40 lbs.
  - Equipment Transportation – Rail
  - Equipment Transportation – Water

- Equipment Use
  - Earthwork
  - Drilling
  - Pump operation
  - Diesel and Gasoline Pumps
  - Blower, Compressor, Mixer, and Other Equipment
  - Generators
  - Agricultural Equipment
  - Capping Equipment
  - Mixing Equipment

- Residual Handling
  - Residue Disposal/Recycling
  - Landfill Operations
  - Thermal/Catalytic Oxidizers
  - Water Consumption
  - Landfill Methane Emissions

- Other Known On-Site Activities

Other Supporting Calculations
Akiachak FSA Pilot GSR Evaluation
On-Site Biological Treatment (Alternative 2)

% of Total Energy Usage from Renewable Resources

- None identified

Hazardous Air Pollutants

- None identified

.

Refined Materials Use

- 15 gallons of microbial product

- Other refined materials assumed to have negligible contribution to total materials use

Unrefined Materials Use

- None identified

Tons of Non-Hazardous Waste

- None identified

Risks to On-Site Workers and from Transportation

- Refer to “Total” tab of the “Summary.xlsx” spreadsheet
- For transportation related risks, sum injuries and fatalities for all transportation activities
- Add total risk form transportation and non-transportation, and then subtract the transportation sums previously calculated, to get non-transportation

Heavy Truck Trips through Residential Areas

- Not quantified, but presumably there will be a significant reduction compared to the baseline option due to the elimination of trips for the loader between the excavation and the barge landing, and the borrow pit and the excavation.

Project: GSR Pilot for Akiachak FSA
Option or Alternative: Alternative 2 (On-Site Biological Treatment)
Current Date: 1/10/2012

year	up-front cost	annual cost	present value of cost each year	cumulative cash flow	
		(no discounting)	3.0%	no discounting	3.0%
0	$103,115	$0	$103,115	$103,115	$103,115
1	$0	$0	$0	$103,115	$103,115
2	$0	$0	$0	$103,115	$103,115
3	$0	$0	$0	$103,115	$103,115
4	$0	$0	$0	$103,115	$103,115
5	$0	$0	$0	$103,115	$103,115
6	$0	$0	$0	$103,115	$103,115
7	$0	$0	$0	$103,115	$103,115
8	$0	$0	$0	$103,115	$103,115
9	$0	$0	$0	$103,115	$103,115
10	$0	$0	$0	$103,115	$103,115
11	$0	$0	$0	$103,115	$103,115
12	$0	$0	$0	$103,115	$103,115
13	$0	$0	$0	$103,115	$103,115
14	$0	$0	$0	$103,115	$103,115
15	$0	$0	$0	$103,115	$103,115
16	$0	$0	$0	$103,115	$103,115
17	$0	$0	$0	$103,115	$103,115
18	$0	$0	$0	$103,115	$103,115
19	$0	$0	$0	$103,115	$103,115
20	$0	$0	$0	$103,115	$103,115
21	$0	$0	$0	$103,115	$103,115
22	$0	$0	$0	$103,115	$103,115
23	$0	$0	$0	$103,115	$103,115
24	$0	$0	$0	$103,115	$103,115
25	$0	$0	$0	$103,115	$103,115
26	$0	$0	$0	$103,115	$103,115
27	$0	$0	$0	$103,115	$103,115
28	$0	$0	$0	$103,115	$103,115
29	$0	$0	$0	$103,115	$103,115
30	$0	$0	$0	$103,115	$103,115

Net Present Value (NPV)-> $103,115

*positive dollar value is a "cost", negative dollar value is a "savings"

GSR Team Calculations to Split Energy Results from SiteWise into "Direct" and "Indirect"
On-Site Biological Treatment (Alternative 2)

phase	Reported by SiteWise		Assigned by GSR Team from SiteWise Output			Added by GSR Team	Total Calculated by GSR Team
			Scope 1 (direct)	Scope 2 (indirect)	Scope 3 (indirect)	Scope 3 (indirect)	
	activity	energy used (MMBTU)	energy used (MMBTU)	energy used (MMBTU)	energy used (MMBTU)	energy used (MMBTU)	
Mobilization and Demobilization of Personnel, Equipment, and Materials (remedial investigation tab)	Consumables	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	5.22	0.00	0.00	5.22	1.25	6.47
	Transportation-Equipment	0.27	0.00	0.00	0.27	0.07	0.34
	Equipment Use and Misc	0.00	0.00	0.00	0.00	0.00	0.00
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-total	5.49	0.00	0.00	5.49	1.32	6.81
Tilling and Treatment (remedial action construction tab)	Consumables	0.44	0.00	0.00	0.44	0.00	0.44
	Transportation-Personnel	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Equipment	0.46	0.00	0.00	0.46	0.11	0.57
	Equipment Use and Misc	17.56	17.56	0.00	0.00	4.22	21.78
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-total	18.46	17.56	0.00	0.90	4.33	22.79
Site Restoration (remedial action operations tab)	Consumables	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Equipment	0.00	0.00	0.00	0.00	0.00	0.00
	Equipment Use and Misc	0.00	0.00	0.00	0.00	0.00	0.00
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-total	0.00	0.00	0.00	0.00	0.00	0.00
Confirmatory Sampling (longterm monitoring tab)	Consumables	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Equipment	0.23	0.00	0.00	0.23	0.06	0.29
	Equipment Use and Misc	0.00	0.00	0.00	0.00	0.00	0.00
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-total	0.23	0.00	0.00	0.23	0.06	0.29
total		24.18	17.56	0.00	6.62	5.70	29.88

Note: For energy use related to fuel use for transportation or on-site equipment use, SiteWise reports energy use associated with combustion only. The added Scope 3 energy use for these activities take into account upstream energy use (i.e. energy required for extraction, refining, etc.). The added energy is based on multipliers used in the GREET software, version 1.8d.1, which in this case equates to multiplying energy used in fuel combustion by 0.24 to calculate the upstream energy use.
Electricity use reported by SiteWise in units of kWh is "Direct Scope 1", meaning it is energy consumed at the location of the project. However, energy use associated with electricity reported by SiteWise in units of MMBtu is a life-cycle value which also includes a factor to account for energy used elsewhere required to generate the electricity ("Indirect Scope 2"). Here, 33% of the life-cycle value reported by SiteWise is considered to be "Scope 1" on-site energy use, and 67% is considered to be "Scope 2" energy used in electricity generation.

GSR Team Calculations to Split GHG Results from SiteWise into "Direct" and "Indirect"
On-Site Biological Treatment (Alternative 2)

phase	Reported by SiteWise: activity	Reported by SiteWise: GHG emitted (metric tons CO2e)	Assigned by GSR Team from SiteWise Output: Scope 1 (direct) GHG emitted (metric tons CO2e)	Assigned by GSR Team from SiteWise Output: Scope 2 (indirect) GHG emitted (metric tons CO2e)	Assigned by GSR Team from SiteWise Output: Scope 3 (indirect) GHG emitted (metric tons CO2e)	Added by GSR Team: Scope 3 (indirect) GHG emitted (metric tons CO2e)	Total Calculated by GSR Team
Mobilization and Demobilization of Personnel, Equipment, and Materials (remedial investigation tab)	Consumables	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	0.45	0.00	0.00	0.45	0.11	0.56
	Transportation-Equipment	0.04	0.00	0.00	0.04	0.010	0.05
	Equipment Use and Misc	0.00	0.00	0.00	0.00	0.00	0.00
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-total	0.49	0.00	0.00	0.49	0.12	0.60
Tilling and Treatment (remedial action construction tab)	Consumables	0.02	0.00	0.00	0.02	0.00	0.02
	Transportation-Personnel	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Equipment	0.07	0.00	0.00	0.07	0.00	0.07
	Equipment Use and Misc	1.00	1.00	0.00	0.00	0.24	1.24
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-total	1.09	1.00	0.00	0.09	0.24	1.34
Site Restoration (remedial action operations tab)	Consumables	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Equipment	0.00	0.00	0.00	0.00	0.00	0.00
	Equipment Use and Misc	0.00	0.00	0.00	0.00	0.00	0.00
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-total	0.00	0.00	0.00	0.00	0.00	0.00
Confirmatory Sampling (longterm monitoring tab)	Consumables	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Equipment	0.04	0.00	0.00	0.04	0.01	0.05
	Equipment Use and Misc	0.00	0.00	0.00	0.00	0.00	0.00
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-total	0.04	0.00	0.00	0.04	0.01	0.05
total		1.62	1.00	0.0000	0.62	0.37	1.99

Note: *For GHG emissions related to fuel use for transportation or on-site equipment use, SiteWise reports emissions associated with combustion only. The added Scope 3 emissions for these activities take into account upstream emissions (i.e. emissions related to extraction, refining, etc.). The added emissions factor is based on multipliers used in the GREET software, version 1.8d.1, which in this case equates to multiplying emission from fuel combustion by 0.24 to calculate the upstream emissions.*

CO2e reported by SiteWise for electricity use is all associated with generation of the electricity ("Indirect Scope 2").

APPENDIX C-2

Alternative 3 – Ex-Situ Thermal Treatment

Appendix C-2
Assumptions for SiteWise Input and Other Calculations
Akiachak FSA Pilot GSR Evaluation
Ex-Situ Thermal Treatment (Alternative 3)

Alternative 3 – Ex-Situ Thermal Treatment – SiteWise "Alternative 3" Directory

Assumptions for this alternative include the following:

- Mobilize and demobilize personnel, equipment, and materials to the Akiachak FSA;
- Locate and excavate DRO-contaminated soil on the east side of the Old Armory;
- Field screen excavated soil, as applicable;
- Collect confirmation soil samples from excavated areas for off-site laboratory analysis;
- Treat water that collects in excavation with GAC polished by alder wood, discharge treated water to ground, and disposed of GAC and alder in landfill in Anchorage;
- Backfill, re-grade, and revegetate areas disturbed by project activities;
- Arrange for off-site thermal treatment of the excavated DRO-contaminated soil;
    - A thermal treatment plant in Bethel has been approved for use by regulators.
    - Treatment would presumably involved barge transport from Akiachak to Bethel.
    - Assume truck transport from barge dock in Bethel to thermal plant
    - Thermal treatment cost is currently estimated at $400 per ton (provided by Project Team).

The notes pertaining to SiteWise input are organized by the following sections of SiteWise input:

- Mobilization and Demobilization of Personnel, Equipment, and Materials – Uses "Remedial Investigation" tab of SiteWise input for SiteWise "Alternative 1"

- Excavation and Sampling – Uses "Remedial Action Construction" tab of SiteWise input for SiteWise "Alternative 1"

- Site Restoration – Uses "Remedial Action Operations" tab of SiteWise input for SiteWise "Alternative 1"

- Transport and Thermal Treatment of Excavated Material – Uses "Longterm Monitoring" tab of SiteWise input for "SiteWise "Alternative 1"

For each section of SiteWise, all the sections are listed, with pertinent information added only for those sections of the input sheet where data were added.

Alternative 3 – Overview

Other calculations done outside of SiteWise are then presented. These include the following:

- % of total energy from renewable resources
- Hazardous air pollutants
- Refined material use
- Unrefined material use
- Tons of non-hazardous waste
- Risks to on-site works and from transportation
- Heavy truck trips through residential areas

Additional tables are attached which show how SiteWise outputs were split into "direct" and "indirect" energy use and greenhouse gas emissions. For definitions of direct and indirect energy use and emissions, please refer to section 2.2.2 of the evaluation report.

A cost sheet is also attached. Cost estimates are partially based on a cost estimate for remedial actions provided by Ahtna, (i.e. modified from the baseline cost estimates provided by Ahtna to account for differences in this alternative). The changes to the Ahtna cost estimate are as follows:

Item	Baseline Cost	Alternative 3 Cost	Explanation for Estimated Change in Cost from Baseline to Alternative 3
Remedial Action Plan	$9,746	$9,746	No anticipated change
Remedial Action Fieldwork (Labor)	$97,101	$97,101	No anticipated change
Equipment	$25,600	$25,600	No anticipated change
Materials	$8,921	$8,921	No anticipated change
Laboratory	$5,003	$5,003	No anticipated change
Contaminated Soil Transportation	$127,979	$8,625	Assume approximately $50 per ton for barge transport of 172.5 tons being transported from Akiachak to Bethel, and subsequent transport to the incinerator.
Contaminated Soil Disposal	$20,873	$69,000	This item is replaced by the cost for thermal treatment of contaminated soil, currently estimated at $400 per ton. Assume treatment of 172.5 tons of contaminated soil.
Travel and ODCs	$36,014	$36,014	No anticipated change
Remedial Action Report	$4,296	$4,296	No anticipated change
Total Cost	**$335,533**	**$264,306**	

Alternative 3 – Overview

Information regarding the cost calculations is as follows:

- The capital cost for this alternative is $264,306
- There is assumed to be no annual O&M cost for this remedy, since the planned action will remediate to unrestricted use.
- Capital costs are assumed to occur in year 0, and annual costs are assumed to occur in years 1 to 30.
- To determine net present value (NPV), a 3 percent discount rate is applied to future costs (since there are no annual costs, the discount rate does not impact the calculation of NPV).
- NPV is calculated by discounting future costs to present-day dollars using the following equation:

$$PV = \frac{FV}{(1+i)^n} = C \times FV$$

PV is the present value
FV is the value in year "n" (i.e., future value)
i is the discount rate
C is the discount factor, which equals $1/(1+i)^n$

Alternative 3 – Mobilization and Demobilization of Personnel, Equipment, and Materials

Scope of Work

- Ahtna field team will include an equipment operator, laborer, and either the project geologist or field scientist (3 people total). Assume the laborer is local (i.e., the other 2 people flying from Anchorage). Transport of personnel by commercial air will be from Anchorage to Akiachak.
- Heavy equipment will include one 100 class excavator and one loader for filling super sacks and backfill. Both are owned by the village, and will be driven a short distance to and from the site (< 1 mile).
- All other field equipment will be transported to and from Akiachak by either barge or air transportation. Assumed to be negligible for footprinting.

Alternative 3 – Mobilization and Demobilization of Personnel, Equipment, and Materials

<u>SiteWise Input – Input into "Remedial Action Investigation" tab of SiteWise "Alternative 3"</u>

- Material Production
  - Well Materials
  - Treatment Chemicals & Materials
  - GAC
  - Construction Materials
  - Well Decommissioning
- Transportation
  - Personnel Transportation – Road
  - Personnel Transportation – Air
    - Trip 1 – Assume 2 individuals on round-trip flight from Anchorage to Akiachak. Distance is ~400 miles one-way = 800 miles round-trip
  - Personnel Transportation – Rail
  - Equipment Transportation – Road
    - Trip 1 – Assume equipment transported ~2 miles round trip to and from site. Assume ~12 tons for the excavator.
    - Trip 2 – Assume equipment transported ~2 miles round trip to and from site. Assume ~12 tons for the loader.
  - Equipment Transportation – Air
  - Equipment Transportation – Rail
  - Equipment Transportation – Water

- Equipment Use
  - Earthwork
  - Drilling
  - Pump operation
  - Diesel and Gasoline Pumps
  - Blower, Compressor, Mixer, and Other Equipment
  - Generators
  - Agricultural Equipment
  - Capping Equipment
  - Mixing Equipment

- Residual Handling
  - Residue Disposal/Recycling
  - Landfill Operations
  - Thermal/Catalytic Oxidizers
  - Water Consumption
  - Landfill Methane Emissions

- Other Known On-Site Activities
  - CO_2 Emissions

Alternative 3 – Excavation and Sampling

Scope of Work

- Use excavator to remove ~115 cy of contaminated soil and fill super sacks
  - Project Team indicated 5 to 8 hours per day (assume 6.5 average) for the first 1.5 weeks and 2 hours per day for the second 1.5 weeks.
- Assume samples sent to lab via courier in 3-4 batches. There are 2 daily scheduled flights round trip from Akiachak to Anchorage (so the samples will not be creating a separate trip).
- Less than 1 mile of transport will be required between the site and the plane, and less than 1 mile from the airport in Anchorage to the lab. Assume negligible for footprinting.
- GAC filtration for water collected in excavation. Assume ~40 lbs (one 5-gallon bucket, quantity estimated by Project Team) transported to and from site by air. Assume transport to Anchorage by air and subsequent transport to landfill by truck.
- Polishing using alder wood cellulose material. Assume ~50 lbs (quantity estimated by Project Team) transported to and from site by air. Assume transport to Anchorage by air and subsequent transport to landfill by truck.

Alternative 3 – Excavation and Sampling

SiteWise Input – Input into "Remedial Action Construction" tab in SiteWise "Alternative 3"

- Material Production
  - Well Materials
  - Treatment Chemicals & Materials
    - Treatment 1 – Mulch used to represent 50 lbs alder wood material for polishing step.
  - GAC
    - Treatment 1 – 40 lbs of GAC for water treatment.
  - Construction Materials
  - Well Decommissioning

- Transportation
  - Personnel Transportation – Road
  - Personnel Transportation – Air
  - Personnel Transportation – Rail
  - Equipment Transportation – Road
  - Equipment Transportation – Air
    - Trip 1 – Coolers for samples. Assume 4 trips for coolers weighing 50 lbs (0.025 tons) per trip. Assume 400 miles one way.
    - Trip 2 – GAC for water treatment. Assume 400 miles one way to deliver GAC to site and 400 miles to landfill disposal. Assume 40 lbs (0.02 tons).
    - Trip 3 – Alder wood for polishing step. Assume 400 miles one way to deliver GAC to site and 400 miles to landfill disposal. Assume 50 lbs (0.025 tons).
    - Trip 4 – Assume 1 trip for shipping coolers with bottles to the site from Anchorage. Assume 10 lbs per cooler * 4 coolers = 40 lbs.
  - Equipment Transportation – Rail
  - Equipment Transportation – Water

- Equipment Use
  - Earthwork
    - Equipment 1 – 1 excavator; assume operation for 10 days for 6.5 hours per day and 10 days for 2 hours per day (10*6.5 + 10*2 = 85 hours of operation). The Project Team has indicated the approximate size of the excavator and the hours of operation. The productivity rates in the SiteWise lookup table for excavator use do not agree with the estimated hours of operation provided by the Project Team, so the productivity rate for the appropriately sized excavator in the SiteWise lookup table was updated to be consistent with their estimate.
  - Drilling
  - Pump operation
    - Pump 1 – 1 bladder or trash type pump for GAC unit. Assume 10 gpm, 20 ft of head, 10 hours of operation total.
  - Diesel and Gasoline Pumps
  - Blower, Compressor, Mixer, and Other Equipment
  - Generators
  - Agricultural Equipment
  - Capping Equipment
  - Mixing Equipment

Alternative 3 – Excavation and Sampling

- Residual Handling
  - Residue Disposal/Recycling
    - Material Residue – GAC and alder wood disposed of in landfill near Anchorage. Assume 20 mile transport via truck from airport. No empty return trip, because it is assumed that this is part of a scheduled shipment. Weight = 40 + 50 = 90 lbs = 0.045 tons.
  - Landfill Operations
  - Thermal/Catalytic Oxidizers
  - Water Consumption
  - Landfill Methane Emissions

- Other Known On-Site Activities

Alternative 3 – Site Restoration

Scope of Work

- Backfilling excavated area and re-grading
  - Analytically-confirmed clean overburden will be used for backfill to the extent possible. The remaining backfill will come from a borrow pit within ~1/4 mile of the site, and the loader will be used to haul this material to the site. Assume ~115 cy to fill excavated area.
  - The loader will also be used to move super sacks containing 115 cy of excavated soil to the barge landing area (~1/2 to 1/4 mile from the site).
  - The Project Team indicated 6-8 hours of loader operation per day for the last 1.5 weeks of remedial action for the tasks listed above.
- Areas disturbed by project activities will be revegetated. The disturbed area will be fertilized and an Alaskan grass seed mixture will be spread over areas disturbed by project activities. This is not footprinted.

Alternative 3 – Site Restoration

<u>SiteWise Input – Input into "Remedial Action Operations" tab in SiteWise "Alternative 3"</u>

- Material Production
  - Well Materials
  - Treatment Chemicals & Materials
  - GAC
  - Construction Materials
  - Well Decommissioning

- Transportation
  - Personnel Transportation – Road
  - Personnel Transportation – Air
  - Personnel Transportation – Rail
  - Equipment Transportation – Road
  - Equipment Transportation – Air
  - Equipment Transportation – Rail
  - Equipment Transportation – Water

- Equipment Use
  - Earthwork
    - Equipment 1 – Loader; assume operation for 10 days for 7 hours per day (70 hours of operation). The Project Team has indicated the approximate size of the loader and the hours of operation. The productivity rates in the SiteWise lookup table for loader use do not agree with the estimated hours of operation provided by the Project Team, so the productivity rate for the appropriately sized loader in the SiteWise lookup table was updated to be consistent with their estimate.
  - Drilling
  - Pump operation
  - Diesel and Gasoline Pumps
  - Blower, Compressor, Mixer, and Other Equipment
  - Generators
  - Agricultural Equipment
  - Capping Equipment
  - Mixing Equipment

- Residual Handling
  - Residue Disposal/Recycling
  - Landfill Operations
  - Thermal/Catalytic Oxidizers
  - Water Consumption
  - Landfill Methane Emissions

- Other Known On-Site Activities

Alternative 3 – Transport and Thermal Treatment of Excavated Material

Scope of Work

- Transport from the excavation area to the barge landing area (½ - ¼ miles). The loader will be used to transport super sacks. Loader hours of operation accounted for in the "Site Restoration" section above.
- Transport via barge from Akiachak to Bethel. The excavated material will likely account for ~½ of the barge's load from Akiachak to Bethel (~25 miles).
- Note: barge transport to Bethel is "piggybacking" on transport that would already have taken place. Therefore, the footprint will be calculated based only on the added fuel use due to the additional weight of the excavated material.
- Assume truck transport from barge dock to incinerator in Bethel, Alaska (assume ~5 miles),
- Thermal treatment of contaminated soil at thermal plant in Bethel, Alaska. For soil incineration assume the following:
    - 172.5 tons (345,000 lbs) of soil
    - Heat capacity of approximately 0.2 btu per lb per F
    - Heating from 50F to 1200 F
    - 80% efficiency for incinerator
- This requires about 100 MMBtu of heat. Assume this heating is to be provided by diesel fuel at 139,000 Btu per gallon, which will require about 720 gallons of diesel.
- Additional electricity is probably required for blowers and conveyor belts. Assume this is less than 200 kWh (e.g., 50 kW for 4 hours).

Alternative 3 – Transport and Thermal Treatment of Excavated Material

<u>SiteWise Input – Input into "Longterm Monitoring" tab in SiteWise "Alternative 3"</u>

- Material Production
    - Well Materials
    - Treatment Chemicals & Materials
    - GAC
    - Construction Materials
    - Well Decommissioning

- Transportation
    - Personnel Transportation – Road
    - Personnel Transportation – Air
    - Personnel Transportation – Rail
    - Equipment Transportation – Road
        - Trip 1 – truck transporting soil from barge dock to thermal plant for treatment. Trip 1 is full loads (assume 9 trips, 5 miles per trip, with ~19 tons per trip to achieve total of 172.5 tons)
        - Trip 2 – truck transporting soil from barge dock to thermal plant for treatment. Trip 2 is empty loads (assume 9 trips, 5 miles per trip, 0 tons added to truck)
    - Equipment Transportation – Air
    - Equipment Transportation – Rail
    - Equipment Transportation – Water
        - Trip 1 – Transport of excavated material via barge from Akiachak to Bethel (~25 miles). Assume 3000 lbs/cy of soil * 115 cy = 345,000 lbs = 172.5 tons.

- Equipment Use
    - Earthwork
    - Drilling
    - Pump operation
    - Diesel and Gasoline Pumps
    - Blower, Compressor, Mixer, and Other Equipment
        - Equipment 1 – Use method 2, assume 50 kW for 4 hours of electricity use for blowers, conveyor belts, etc,
    - Generators
        - Generator 1 – Used to account for diesel fuel use for heating. Select 16 to 25 horsepower and 440 hours of use, which (according to the Longterm Monitoring output file) will use approximately 720 gallons of diesel and provide 100 MMBtu of energy output (see notes in scope of work above).
    - Agricultural Equipment
    - Capping Equipment
    - Mixing Equipment

- Residual Handling
    - Residue Disposal/Recycling
    - Landfill Operations
    - Thermal/Catalytic Oxidizers
    - Water Consumption – Purge water from sampling is negligible
    - Landfill Methane Emissions

Alternative 3 – Transport and Thermal Treatment of Excavated Material

- Other Known On-Site Activities

Other Supporting Calculations
Akiachak FSA Pilot GSR Evaluation
Ex-Situ Thermal Treatment (Alternative 3)

% of Total Energy Usage from Renewable Resources

- None identified. Perhaps a negligible amount associated with electricity generation used for pump on-site, and blowers and conveyor belts at the thermal treatment plant in Bethel.. According to eGRID (http://cfpub.epa.gov/egridweb/view_srl.cfm), the percentage of electricity from renewable sources for region AKMS is ~66% (most of which is hydropower), but the amount from renewable at this site is still negligible because electricity use represents such a small portion of the overall energy use for this alternative.

Hazardous Air Pollutants

- None identified

.

Refined Materials Use

- 40 lbs GAC (assume 100% virgin)

- Other refined materials assumed to have negligible contribution to total materials use

Unrefined Materials Use

- 50 lbs alder mulch (assumed to be recycled)

Tons of Non-Hazardous Waste

- 0 tons for excavated soil (assume treated soil will be placed back on site or re-used elsewhere, will not be considered waste)
- 0.045 tons for GAC plus alder mulch

Risks to On-Site Workers and from Transportation

- Refer to “Total” tab of the “Summary.xlsx” spreadsheet
- For transportation related risks, sum injuries and fatalities for all transportation activities
- Add total risk form transportation and non-transportation, and then subtract the transportation sums previously calculated, to get non-transportation

Heavy Truck Trips through Residential Areas

- Not quantified, but many given the proximity of the village and the many trips expected for the loader between the borrow pit and the excavation.

Project: GSR Pilot for Akiachak FSA
Option or Alternative: Alternative 3 (Ex-Situ Thermal Treatment)
Current Date: 1/10/2012

year	up-front cost	annual cost	present value of cost each year	cumulative cash flow	
		(no discounting)	3.0%	no discounting	3.0%
0	$264,306	$0	$264,306	$264,306	$264,306
1	$0	$0	$0	$264,306	$264,306
2	$0	$0	$0	$264,306	$264,306
3	$0	$0	$0	$264,306	$264,306
4	$0	$0	$0	$264,306	$264,306
5	$0	$0	$0	$264,306	$264,306
6	$0	$0	$0	$264,306	$264,306
7	$0	$0	$0	$264,306	$264,306
8	$0	$0	$0	$264,306	$264,306
9	$0	$0	$0	$264,306	$264,306
10	$0	$0	$0	$264,306	$264,306
11	$0	$0	$0	$264,306	$264,306
12	$0	$0	$0	$264,306	$264,306
13	$0	$0	$0	$264,306	$264,306
14	$0	$0	$0	$264,306	$264,306
15	$0	$0	$0	$264,306	$264,306
16	$0	$0	$0	$264,306	$264,306
17	$0	$0	$0	$264,306	$264,306
18	$0	$0	$0	$264,306	$264,306
19	$0	$0	$0	$264,306	$264,306
20	$0	$0	$0	$264,306	$264,306
21	$0	$0	$0	$264,306	$264,306
22	$0	$0	$0	$264,306	$264,306
23	$0	$0	$0	$264,306	$264,306
24	$0	$0	$0	$264,306	$264,306
25	$0	$0	$0	$264,306	$264,306
26	$0	$0	$0	$264,306	$264,306
27	$0	$0	$0	$264,306	$264,306
28	$0	$0	$0	$264,306	$264,306
29	$0	$0	$0	$264,306	$264,306
30	$0	$0	$0	$264,306	$264,306

Net Present Value (NPV)-> $264,306

*positive dollar value is a "cost", negative dollar value is a "savings"

GSR Team Calculations to Split Energy Results from SiteWise into "Direct" and "Indirect"
Ex-Situ Thermal Treatment (Alternative 3)

phase	activity	Reported by SiteWise energy used (MMBTU)	Assigned by GSR Team from SiteWise Output: Scope 1 (direct) energy used (MMBTU)	Assigned by GSR Team from SiteWise Output: Scope 2 (indirect) energy used (MMBTU)	Assigned by GSR Team from SiteWise Output: Scope 3 (indirect) energy used (MMBTU)	Added by GSR Team: Scope 3 (indirect) energy used (MMBTU)	Total Calculated by GSR Team
Mobilization and Demobilization of Personnel, Equipment, and Materials (remedial investigation tab)	Consumables	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	5.22	0.00	0.00	5.22	1.25	6.47
	Transportation-Equipment	0.08	0.00	0.00	0.08	0.02	0.10
	Equipment Use and Misc	0.00	0.00	0.00	0.00	0.00	0.00
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-total	5.30	0.00	0.00	5.30	1.27	6.57
Excavation and Sampling (remedial action construction tab)	Consumables	2.20	0.00	0.00	2.20	0.00	2.20
	Transportation-Personnel	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Equipment	0.81	0.00	0.00	2.00	0.48	2.48
	Equipment Use and Misc	1.64	1.64	0.01	0.00	0.39	2.04
	Residual Handling	0.31	0.00	0.00	0.31	0.07	0.38
	Sub-total	4.96	1.64	0.01	4.51	0.95	7.10
Site Restoration (remedial action operations tab)	Consumables	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Equipment	0.00	0.00	0.00	0.00	0.00	0.00
	Equipment Use and Misc	12.64	12.64	0.00	0.00	3.03	15.68
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-total	12.64	12.64	0.00	0.00	3.03	15.68
Transport and Thermal Treatment of Excavated Material (longterm monitoring tab)	Consumables	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Equipment	4.06	0.00	0.00	4.06	0.97	5.03
	Equipment Use and Misc	102.10	100.71	1.39	0.00	24.01	126.10
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-total	106.15	100.71	1.39	4.06	24.98	131.13
total		129.06	114.99	1.39	13.86	30.23	160.48

Note: For energy use related to fuel use for transportation or on-site equipment use, SiteWise reports energy use associated with combustion only. The added Scope 3 energy use for these activities take into account upstream energy use (i.e. energy required for extraction, refining, etc.). The added energy is based on multipliers used in the GREET software, version 1.8d.1, which in this case equates to multiplying energy used in fuel combustion by 0.24 to calculate the upstream energy use.

Electricity use reported by SiteWise in units of kWh is "Direct Scope 1", meaning it is energy consumed at the location of the project. However, energy use associated with electricity reported by SiteWise in units of MMBtu is a life-cycle value which also includes a factor to account for energy used elsewhere required to generate the electricity ("Indirect Scope 2"). Here, 33% of the life-cycle value reported by SiteWise is considered to be "Scope 1" on-site energy use, and 67% is considered to be "Scope 2" energy used in electricity generation.

GSR Team Calculations to Split GHG Results from SiteWise into "Direct" and "Indirect"
Ex-Situ Thermal Treatment (Alternative 3)

phase	activity	Reported by SiteWise: GHG emitted (metric tons CO2e)	Assigned by GSR Team from SiteWise Output: Scope 1 (direct) GHG emitted (metric tons CO2e)	Assigned by GSR Team from SiteWise Output: Scope 2 (indirect) GHG emitted (metric tons CO2e)	Assigned by GSR Team from SiteWise Output: Scope 3 (indirect) GHG emitted (metric tons CO2e)	Added by GSR Team: Scope 3 (indirect) GHG emitted (metric tons CO2e)	Total Calculated by GSR Team
Mobilization and Demobilization of Personnel, Equipment, and Materials (remedial investigation tab)	Consumables	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	0.45	0.00	0.00	0.45	0.11	0.56
	Transportation-Equipment	0.01	0.00	0.00	0.01	0.00	0.01
	Equipment Use and Misc	0.00	0.00	0.00	0.00	0.00	0.00
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-total	0.45	0.00	0.00	0.45	0.11	0.56
Excavation and Sampling (remedial action construction tab)	Consumables	0.12	0.00	0.00	0.12	0.00	0.12
	Transportation-Personnel	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Equipment	0.13	0.00	0.00	0.13	0.03	0.16
	Equipment Use and Misc	0.08	0.08	0.0002	0.00	0.02	0.09
	Residual Handling	0.03	0.00	0.00	0.03	0.01	0.04
	Sub-total	0.36	0.08	0.00	0.28	0.06	0.41
Site Restoration (remedial action operations tab)	Consumables	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Equipment	0.00	0.00	0.00	0.00	0.00	0.00
	Equipment Use and Misc	0.86	0.86	0.00	0.00	0.21	1.06
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-total	0.86	0.86	0.00	0.00	0.21	1.06
Transport and Thermal Treatment of Excavated Material (longterm monitoring tab)	Consumables	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Equipment	0.34	0.00	0.00	0.34	0.08	0.42
	Equipment Use and Misc	4.03	3.98	0.05	0.00	0.96	4.98
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-total	4.36	3.98	0.05	0.34	1.04	5.40
total		6.03	4.91	0.0456	1.07	1.41	7.44

Note: *For GHG emissions related to fuel use for transportation or on-site equipment use, SiteWise reports emissions associated with combustion only. The added Scope 3 emissions for these activities take into account upstream emissions (i.e. emissions related to extraction, refining, etc.). The added emissions factor is based on multipliers used in the GREET software, version 1.8d.1, which in this case equates to multiplying emission from fuel combustion by 0.24 to calculate the upstream emissions.*

CO2e reported by SiteWise for electricity use is all associated with generation of the electricity ("Indirect Scope 2").

FINAL REPORT

PILOT PROJECT
GREEN AND SUSTAINABLE REMEDIATION EVALUATION: FORMER BLACK HILLS ARMY DEPOT IGLOO, SOUTH DAKOTA

Prepared for:

U.S. Army Corps of Engineers
Environmental and Munitions Center of Expertise
1616 Capitol Ave, Suite 9200
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Contract No. W912DQ-08-D-0019
Delivery Order No. ZW02

Prepared by:

Tetra Tech EC, Inc.
1000 American Rd.
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12 January 2012

CONTENTS

List of Appendices

PREFACE

The US Army Engineering and Support Center, Huntsville (USAESCH), Environmental and Munitions Center of Expertise (EM CX) has contracted Tetra Tech EC, Inc. (Tetra Tech) under Contract W912DQ-08-D-0019, Delivery Order No. ZW02, to conduct and document a Study that follows the process of considering, incorporating, documenting, and evaluating the benefits of green and sustainable remediation (GSR) practices. The objective of this Task Order is to: (1) Follow the consideration and incorporation of GSR practices into Army environmental remediation projects; (2) Ascertain the effectiveness of the GSR practices that are considered and incorporated; and (3) Provide procedures by which GSR practices that are shown to be effective can be identified, considered, implemented and documented by Project Teams working on Army sites. The information obtained from this Study will be used to provide recommendations to the Office of the Assistant Chief of Staff for Installation Management (OACSIM) for development of Army-wide GSR guidance and policy. This document has been prepared in accordance with the Task Order Statement of Work (SOW) entitled "*Evaluation of Consideration and Incorporation of Green and Sustainable Remediation (GSR) Practices in Army Environmental Remediation*" (26 July 2010).

The Project Delivery Team (PDT) consists of representatives and subject matter experts (SMEs) from the following organizations:

- EM CX;
- OACSIM;
- National Guard Bureau (NGB);
- Army Environmental Command (AEC);
- Tetra Tech;
- Office of the Deputy Assistant Secretary of the Army-Environment, Safety, and Occupational Health (ODASA (ESOH));
- Headquarters US Army Corps of Engineers (HQ USACE) Formerly Used Defense Sites (FUDS) program;
- HQ USACE Environmental Community of Practice (ECoP) Military Munitions Support Services (M2S2);
- Huntsville Center Environmental Program; and
- Army Environmental Policy Institute (AEPI)

Specific representatives of those organizations are listed on the table at the end of this preface. This report pertains to one of the pilot projects conducted as part of the Study. Tetra Tech personnel who provided the most significant contributions to this report are as follows:

- Preparation
  - Rob Greenwald (Project Manager)
  - Sarah Farron

- Review
  - Doug Sutton (IRP GSR Technical Lead)
  - Michelle Caruso (MMRP GSR Technical Lead)

Sincere thanks are extended to Project Team associated with this pilot project, for their willingness to participate in this Study and for their efforts that were associated with their participation.

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Professional in Charge:

Douglas J Sutton

Doug Sutton, PhD, PE, LEED

1/12/12

Date

ACRONYMS AND ABBREVIATIONS

ABP	Agent Breakdown Products
ACSIM	Assistant Chief of Staff for Installation Management
AEC	Army Environmental Command
AEPI	Army Environmental Policy Institute
BG-1	Burial Ground #1
BG-2	Burial Ground #2
BHAD	Black Hills Army Depot
BIP	Blow in Place
BMPs	Best Management Practices
CA	Chemical Agent
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CG	Phosgene
CK	Cyanogen Chloride
CO2	Carbon dioxide
CO2e	Equivalent Global Warming Potential of Carbon Dioxide
CSM	Conceptual Site Model
CWBPA	Chemical Warfare Burning Pit Area
CWM	Chemical Warfare Materiel
DGM	Digital Geophysical Mapping
DERP	Defense Environmental Restoration Program
DMM	Discarded Military Munitions
DoD	Department of Defense
ECoP	Environmental Community of Practice
EM CX	Environmental and Munitions Center of Expertise
ESOH	Environment, Safety, and Occupational Health
FUDS	Formerly Used Defense Sites
GHG	Greenhouse gas
GSR	Green and Sustainable Remediation
H	Mustard gas
HQ USACE	Headquarters US Army Corps of Engineers
HRS	Hours
HTW	Hazardous and Toxic Waste
IDW	Investigation Derived Waste
IHF	Interim Holding Facility
IRP	Installation Restoration Program
Kg	Kilograms
lbs	Pounds
MC	Munitions Constituents
MEC	Munitions and Explosives of Concern
M2S2	Military Munitions Support Services
MMBtu	Million Metric British Thermal Units
MMRP	Military Munitions Response Program
MRS	Munitions Response Site
NGB	National Guard Bureau
NOx	Nitrogen Oxides
NPV	Net present value
OACSIM	Office of the Assistant Chief of Staff for Installation Management
ODASA	Office of the Deputy Assistant Secretary of the Army

OU-1	Operable Unit-1
OU-2	Operable Unit-2
Paleo	Paleontology
PDT	Project Delivery Team
PM	Particulate Matter
PPE	Personal Protective Equipment
RCWM	Recovered Chemical Warfare Materiel
RECs	Renewable Energy Certificates
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
SiteWise	Battelle SiteWise™ Sustainable Environmental Remediation Tool
SMEs	Subject matter experts
SOW	Statement of Work
SOx	Sulfur Oxides
STEL	Short Term Exposure Limit
SVOCs	Semi-volatile Organic Compounds
TCLP	Toxicity Characteristic Leaching Procedure
TSDF	Treatment, Storage, and Disposal Facility
US	United States
USACE	United States Army Corps of Engineers
USAESCH	US Army Engineering and Support Center, Huntsville
USDA	United States Department of Agriculture
UXO	Unexploded Ordnance
VOCs	Volatile Organic Compounds

1.0 INTRODUCTION

1.1 ACSIM GSR STUDY AND PURPOSE OF THIS GSR EVALUATION

The US Army Engineering and Support Center, Huntsville (USAESCH), Environmental and Munitions Center of Expertise (EM CX) has contracted Tetra Tech EC, Inc. (Tetra Tech) under Contract W912DQ-08-D-0019, Delivery Order No. ZW02, to conduct and document a study that follows the process of considering, incorporating, documenting, and evaluating the benefits of green and sustainable remediation (GSR) practices (hereafter referred to as "the Study"). Pursuant to the Department of Defense (DoD) Memorandum "*Consideration of Green and Sustainable Remediation Practices in the Defense Environmental Restoration Program*" (DoD, 2009), GSR employs strategies throughout the remedial process that:

- Use natural resources and energy efficiently;
- Reduce negative impacts on the environment;
- Minimize or eliminate pollution at its source;
- Protect and benefit the community at large; and
- Reduce waste to the greatest extent possible.

The objective of the Study is to: (1) Follow the consideration and incorporation of GSR practices into Army environmental remediation projects; (2) Ascertain the effectiveness of the GSR practices that are considered and incorporated; and (3) Provide procedures by which GSR practices that are shown to be effective can be identified, considered, implemented and documented by project teams working on Army sites. The information obtained from this Study will be used to provide recommendations to the Office of the Assistant Chief of Staff for Installation Management (OACSIM) for development of Army-wide GSR guidance and policy.

One component of the Study is to perform a GSR evaluation at 12 Army "Pilot Projects" that are in various phases of the remedial process. This report presents the Pilot Project GSR Evaluation for the Former Black Hills Army Depot (hereafter referred to as "Former BHAD") Remedial Investigation/Feasibility Study (RI/FS) project. This GSR evaluation has been conducted using an approach developed during the Study and documented in the following report: *Process for Consideration and Incorporation of Green and Sustainable Remediation (GSR) Practices in Army Environmental Remediation (final report dated 26 May 2011)* available at:

https://casi.erdc.usace.army.mil/focusareas/green_remediation/?contentRegion=Item&id=62056

One purpose for the pilot projects is to provide testing of the GSR approach developed during the Study. That approach will be refined and finalized later in the Study based on lessons learned from this and other pilot projects. In addition, it is anticipated that this GSR evaluation may provide the Project Team for the Former BHAD with information and/or recommendations that will be beneficial for their project.

This report refers to "teams" that are defined as follows:

- Study Team: This is the team conducting the Study being led by USACE EM CX that follows the process of considering, incorporating, documenting, and evaluating the benefits of green and sustainable remediation practices for Army projects.

- Project Team: Refers to those associated with implementation of the remedial process for the pilot projects.

- GSR Team: Refers to the personnel that perform a specific GSR evaluation. For this Study, the GSR Team consists of personnel from Tetra Tech, which is a contractor to USACE for the Study.

In this Study, an "EM CX liaison" for each of the pilot projects serves as a bridge between the USACE Study project manager (Carol Dona), the Study contractor performing the GSR evaluation (Tetra Tech), and the Project Team manager for the specific pilot. For this pilot project the EM CX liaison is Nick Stolte.

1.2 TECHNICAL OVERVIEW

1.2.1 Overview of Site Location, History, and Munitions Response Sites

The former BHAD is located in the southwest corner of South Dakota, approximately 30 miles southwest of Hot Springs, South Dakota. BHAD, originally called Black Hills Ordnance Depot, was established in 1942, and included 21,095 acres used to store, maintain, demilitarize, and issue conventional and chemical munitions. Several areas were associated with the disposal of chemical filled munitions and chemical warfare agents. The facility closed in 1967, and subsequently the majority of munitions were shipped to other facilities or destroyed on site. The United States Department of Agriculture (USDA) owns the majority of the land associated with the former BHAD.

This GSR evaluation pertains to RI/FS activities associated with three Munitions Response Sites (MRSs) at the former BHAD (see Figure 1-1 for MRS locations), as summarized below:

- Chemical Warfare Burning Pit Area (CWBPA): Operable Unit 2 (OU-2)

    - The CWBPA encompasses approximately 21 acres within the Chemical Plant Area (113 acres) located in the northwestern corner of the former BHAD.

    - The Chemical Plant Area (of which CWBPA is a portion) was used from 1949 through the 1960s for the draining, renovation, and destruction of mustard (H), cyanogen chloride (CK), and phosgene (CG) bombs ranging in size from 100 to 1,000 lbs.

- Burial Ground #1 (BG-1): part of OU-1

    - BG-1 is in the south central portion of BHAD. The area comprises approximately 220 acres and was the BHAD ordnance disposal area prior the construction of BG-2 in 1946.

    - The area was reportedly used for the destruction of munitions containing chemical agents, incendiary materials, and high explosives. Destruction was reportedly performed by burning and/or detonation. Based on previous investigations conducted at the site, the area has been subdivided into the following 6 sub-areas:

        - DP-17A – one trench approximately 500 feet by 50 feet.
        - DP-17B – two trenches ranging from approximately 500 to 700 feet by 50 feet.
        - DP-17C – two trenches ranging from approximately 300 to 800 feet by 50 feet.

      - DP-17D through DP-17F - disturbed areas.

- Burial Ground #2 (BG-2): part of OU-1

  - BG-2 is in the southwestern portion of BHAD. The area encompasses approximately 1,627 acres with its southern and eastern limits extending outside the BHAD boundary.

  - BG-2 was constructed in 1946 as a facility for the demolition and burning of small arms ammunition, conventional weapons, bombs (high explosive, chemical and incendiary), grenades, mines, rockets, and munitions components. Many of the structures for the area, such as the demolition shelter, store house and popping furnace, are still intact. According to the former Demolition Foreman, chemicals (including mustard agent) were poured into trenches 20 to 25 feet deep and were allowed to seep into the ground. Occasionally, chemical bombs were not placed in pits but were burned along the sides of the roads at BG-2. Large bombs were detonated in 12 pits, which ranged from 20 to 40 feet deep and which were reportedly in continual use at the burning ground. After detonation charges were connected to ignition wires, the munitions and charges were buried with earthen materials and detonated. All large detonations were initiated from behind the remote control shelter. Smaller bombs were placed in open sites and detonated in place, and small ammunition components such as primers, igniter tubes, etc. were burned in the popping furnace. Burned out components were then placed on the ground in the vicinity of the popping furnace. Based on previous investigations conducted at the site, the area has been subdivided into the following 6 sub-areas:

    - DP-18A – Two trenches opposite sides of Demo Road. Approximately 300 feet by 50 feet.
    - DP-18B – 85 acres identified as "burning area".
    - DP-18C – 70 acres known as demolition area.
    - DP-18D – three trenches; two each 500 feet by 50 feet and one each 300 feet by 50 feet.
    - DP-18E – 7 acres, unknown use, possible trenches.
    - DP-18F – 6 acres near former demo furnace.

The Project Team indicated there are no wetlands at any of these sites, and there are no threatened or endangered species. There are some paleontology sites and the potential areas have been previously mapped, but the likelihood of disturbing such areas during the RI/FS is considered small by the Project Team since they would have likely already been disturbed by previous disposal operations.

1.2.2 Contamination, Remedial Phase and Status

The RI/FS at the former BHAD is a project conducted within the Military Munitions Response Program (MMRP). In 1986 Congress established the Defense Environmental Restoration Program (DERP) to provide for the cleanup of Department of Defense (DoD) sites. In 2002 Congress established the MMRP under DERP to address unexploded ordnance (UXO), discarded military munitions (DMM) and munitions constituents (MC) located on current and Formerly Used Defense Sites (FUDS). Generally, MMRP remedies are conducted under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA).

The purpose of the RI/FS at the former BHAD is to:

- Characterize the nature and extent of chemical warfare materiel (CWM), munitions and explosives of concern (MEC), and associated munitions constituent (MC) contamination;

- Evaluate risk; and

- Evaluate remedial alternatives

Based on site documents, the conceptual site model (CSM) for the former BHAD indicates that both MEC and CWM are potentially present in surface and subsurface soil. Furthermore, potentially complete exposure pathways are present at the three MRSs that might result in commercial/industrial workers (e.g., ranchers, site workers) and site visitors or recreational users being exposed to explosive hazards if MEC contamination is present and/or chemical hazards if CWM is present. The following contaminants are potentially present in surface and subsurface soil at the MRSs:

- Chemical agents and agent breakdown products (CA/ABPs)
- Explosives
- Metals
- Volatile organic compounds (VOCs)
- Semi-volatile organic compounds (SVOCs)

Groundwater contamination is not anticipated at the project site, because groundwater is not expected to be found above bedrock; therefore, migration via leaching is considered to be highly unlikely. Additionally, since there is no perennial surface water present, exposure via surface water or sediment migration pathways is also not anticipated. For these reasons, both the groundwater and surface water/sediment exposure pathways are considered to be incomplete for all receptors at BHAD. Based on the above information, potentially complete exposure pathways are present at the site that might result in commercial/industrial workers (e.g., ranchers, site workers), site visitors, and ecological receptors being exposed to MC in surface and/or subsurface soil if contamination is present.

The RI field activities are in progress. Some of the RI field activities (geophysics) were completed in 2011, and the remainder of the RI field investigation (intrusive investigation and MC sampling) will be conducted starting in spring of 2012. Thus, this GSR evaluation has been performed during the execution of the RI Work Plan.

1.2.3 Overview of Planned RI Field Activities

The overall investigation can be divided into the MEC/CWM investigation and the MC investigation:

- *MEC/CWM Investigation.* Methods used during the investigation include ground-based and airborne digital geophysical mapping (DGM). Geophysical surveys were conducted to characterize the density of subsurface anomalies and identify the locations of expected disposal trenches. After the geophysical investigation is completed, test pits will characterize potential disposal pits and trenches. Single point anomaly and grid locations will be also be selected for intrusive investigation. These areas will be intrusively investigated to characterize the nature and define the extent of MEC/CWM contamination. Results of these MEC/CWM investigations may also be used to focus the collection of samples for the MC investigation.

- *MC investigation*. This will be conducted by collecting discrete soil samples within the test pits across the MRSs, at single point anomaly locations at CWPBA, and in grids at BG-1 and BG-2. The sampling will be focused on known or suspected areas of MEC/CWM contamination, as identified during the intrusive investigations. If potential MC contamination is identified during this initial phase, additional sampling will be conducted to define the nature and extent of this MC contamination, and to provide sufficient data to conduct a risk assessment.

RI objectives and scope details for the different MRSs are presented below.

- RI Objectives for the Chemical Warfare Burning Pit Area (CWBPA):
    - Confirm the location and lateral extent (within five feet) of the three previously identified trench-like anomalies using ground-based DGM.
    - Identify other potential disposal pits within the MRS using ground-based DGM.
    - Establish test pits within suspect disposal pits/trenches to characterize their nature and evaluate vertical extent.
    - Evaluate single point anomalies (up to 100 locations) across the MRS to assess whether single MEC/CWM items were disposed by burial in the area.
    - Evaluate the potential presence of CA, ABPs, MC, and hazardous and toxic waste (HTW) constituents in soil within test pits and at single point anomaly locations where MEC/CWM contamination is suspected.
- RI Scope Details for the CWBPA:
    - Geophysical mapping for the CWBPA is all ground-based (compared to air-based plus ground-based plus ground-based for BG-1 and BG-2), and includes evaluation of single point anomalies.
    - Geophysical surveys for 100% of potential trenches covered with G-858 vertical gradient magnetometers array linked to a survey-grade GPS. Other areas surveyed with an approximately 15-ft line spacing. Inaccessible areas cover with single portable G-858 ~15-ft line spacing.
    - Intrusive investigations in the form of test pits and single-point anomaly excavation as follows:
        - Test pits will be excavated using a medium size excavator. Excavation will begin outside the anomaly and move inward. Material will be visually observed during excavation. Depth to natural soils will be identified.
        - Single-Point anomalies will be selected for investigation to provide site-wide coverage with a focus on larger anomalies. These will be performed using a combination of hand tools and mechanical means.

- MC sampling within test pits and areas of suspected contamination as follows:

    - Characterize material in trenches and assess the potential of contaminant migration out of trenches through test pit excavation. Approximately 14 discrete soil samples will be collected per test pit. Samples will be collected when contamination is indicated/suspected or to evaluate the extent of contamination.

    - Samples will be collected in other areas where contamination is suspected.

- RI Objectives for Burning Ground #1 (BG-1) and Burial Ground #2 (BG-2):

    - Evaluate anomaly distribution across each MRS and delineate potential disposal pits using airborne and ground-based DGM. Delineate and characterize low, medium and high anomaly density areas and select appropriate locations for placement of geophysical grids.

    - Establish test pits within suspect disposal pits/trenches to characterize their nature and evaluate vertical extent.

    - Excavate grids in low anomaly density areas and use results to evaluate the presence of MEC/CWM contamination as a result of possible "kickout" during disposal activities.

    - Excavate grids in medium and high anomaly density areas and use results to support development of remedial alternatives for the FS.

    - Evaluate the potential presence of CA, ABPs, MC, and HTW constituents in soils within test pits and at grid locations where MEC/CWM contamination is suspected.

- RI Scope Details for BG-1 and BG-2:

    - Geophysical mapping for BG-1 and BG-2 using an airborne platform in addition to ground-based (compared to all ground-based for the CWBPA), and investigation of anomalies for BG-1 and BG-2 will be grid-based.

    - Airborne geophysical survey was planned over areas with an anticipated coverage of 100% over 90% of the MRS. This work was conducted in the summer of 2011 and the aerial coverage was somewhat less than 90%. During the Step 5 GSR teleconference it was stated that the survey was flown via helicopter based in Toronto, Canada over an approximate 10 day field effort.

    - Airborne DGM data gaps filled in with man-portable transects on 50 foot line spacing.

    - Approximately 3 acres of 50 by 150 foot grids placed based on the results of the airborne DGM surveys. The grid locations will be selected to represent areas with low, medium, and high anomaly density.

    - 100% DGM coverage for suspected disposal trenches.

Waste characterization sampling will be conducted to allow proper disposal of all investigation derived waste (IDW) during the RI activities. With respect to waste and waste disposal, the following elements of the planned work are noted:

- Soil wastes. There are four potential endpoints for excavated soil:
    - *Chemical agent (CA) disposal*. If CA is detected in a headspace sample above the Short Term Exposure Limit (STEL), it will be decontaminated on-site until it is below the STEL, and then sent for off-site disposal as "CA contaminated". If CA is not detected in the headspace sample, but is detected in the low level extraction analysis, it will also be sent for off-site disposal as "CA contaminated". This waste will be incinerated at a facility in Port Arthur, Texas.
    - *Hazardous waste disposal.* If no CA is detected, but hazardous constituents are detected and subsequently determined to be above Toxicity Characteristic Leaching Procedure (TCLP) criteria, that soil will be disposed of as hazardous waste at a facility that operates as a Treatment, Storage, and Disposal Facility (TSDF) under RCRA regulations (the Work Plan does not identify a specific disposal location).
    - *Non-hazardous waste disposal*. If CA is not detected, and hazardous constituents are detected but are subsequently determined to be below TCLP criteria, that soil will be disposed of as non-hazardous waste (the Work Plan does not identify a specific disposal location). In addition, soil that is not contaminated but is not suitable for use as backfill will be disposed of as non-hazardous waste.
    - *Re-use such as for backfill.* Soils that are found to be uncontaminated and that are suitable for use as backfill will remain on site for re-use. Backfilling will be conducted using heavy equipment such as front end loaders and other equipment. For backfilling excavations, prior to adding clean soil, the existing excavations will be covered with a layer of geotextile fabric to create a barrier between the native soils and the new clean fill soil. A compactor will be used to minimize settling of the fill soil. The disturbed ground surface will be reseeded with grass seed and straw, if approved by the landowner.
- *Personal Protective Equipment (PPE) wastes.* Wastes from disposal of PPE will be created daily during intrusive activities (e.g., boots, fabric, tape, disposable outer garments, and plastic sheeting). For the day the PPE is used, if there are no detections of CA during air monitoring conducted during intrusive operations and no detections in soil samples (if collected), the PPE waste can be packaged in plastic bags, labeled as "used, not contaminated" and disposed of as solid waste (trash) in a dumpster or other similar container. If CA is detected during that day's activities, the PPE wastes will be sealed within a drum and will subsequently be sent for off-site disposal as "CA contaminated" to be incinerated at a facility in Port Arthur, Texas (if head-space analysis for CA is above the STEL, on-site decontamination will be required before the off-site disposal).
- Water Waste. Gray water will be produced through equipment and personnel decontamination, and such water will be collected daily in holding tanks or drums. These wastes undergo a series of sampling based on whether or not CA, suspected recovered CWM (RCWM), or soils otherwise suspected of contamination were encountered that day. Those tests determine if CA sampling on the water is performed, and if CA is subsequently detected, that water will be disposed of off-site as "CA contaminated". Otherwise, the water will be disposed of as hazardous or non-hazardous

waste, depending on the results for soils sampling from that day's activities.

- *MEC removal and disposal*. MEC encountered will be detonated on the day found, if possible, using blow in place (BIP) procedures. If MEC cannot be detonated on the day it is found, 24-hour security will be provided until the item(s) can be detonated. Unfuzed MEC may be moved for consolidation with an item that cannot be moved in order to reduce the number of demolition shots required.

It is not possible to provide the quantities of waste disposal for each category of waste until after the RI activities are complete.

1.3 DOCUMENTS REVIEWED AND CALLS/MEETINGS CONDUCTED

The following project documents were reviewed for the GSR evaluation:

- *Final Public Involvement Plan: Former Black Hills Army Depot Remedial Investigation / Feasibility Study* (Parsons, May 2011).
- *Draft Work Plan for Black Hills Army Depot Remedial Investigation and Feasibility Study* (Parsons, April 2011).
- *Final Technical Project Planning Memorandum & Associated Documentation in Support of Remedial Investigation / Feasibility Study* (Parsons, April 2011).
- Slides from *"Technical Project Planning – Working Session", 22 November 2010.*

Pursuant to the GSR approach implemented in the Study, an introductory conference call (referred to as the "Step 3" call) was conducted on 24 May 2011. Items discussed on this call included the following:

- The scope of the GSR evaluation and personnel involved.
- It was noted that this will be one of several MMRP pilot projects in the Study, but this will be the only pilot project in the Study involving CWM.
- The schedule of the GSR evaluation, within the context of how the GSR evaluation could best be integrated into the overall efforts and schedule of the Project Team. This pilot project will have some of the RI work completed this year and some completed next year, and the GSR evaluation schedule is not constrained by the Project Team schedule. The GSR results can potentially be discussed in the Final RI/FS Report, if desired by the Project Team.
- An initial date for the more detailed "Step 5" call was preliminarily scheduled for 12 July 2011. This call was subsequently re-scheduled to 16 August 2011.

Participants for the "Step 3" call are listed in Table 1-1.

Table 1-1
Step 3 Call Participants, 24 May 2011

Participants			
Name	**Organization**	**Phone**	**Email**
Carol Dona	EM CX	402.697.2582	Carol.L.Dona@usace.army.mil
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Ashley Roeske	USAESCH	256.895.1429	Ashley.E.Roeske@usace.army.mil
Ken Shott	USAESCH	256.656.2405	Kenneth.d.shott@usace.army.mil
Chris Ten Braak	Parsons	303.764.1923	Chris.TenBraak@parsons.com
Michelle Caruso	Tetra Tech	973.630.8128	Michelle.Caruso@tetratech.com
Sarah Farron	Tetra Tech	732.409.0344	sarah.farron@tetratech.com

A more detailed conference call, referred to as the "Step 5" conference call, was conducted on 16 August 2011 and lasted approximately two hours. During this call the GSR Team used the list of GSR Best Management Practices (BMPs) developed for the Study as an outline to ask questions to the Project Team and allow the Project Team to provide pertinent information to the GSR Team. Participants for the "Step 5" call are listed in Table 1-2.

Table 1-2
Step 5 Call Participants, 16 August 2011

Participants			
Name	**Organization**	**Phone**	**Email**
Nick Stolte	EM CX	256.895.1595	Nicholas.J.Stolte@usace.army.mil
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Subsequent to the Step 5 call, the Project Team provided the GSR Team (via email) with an estimate regarding the total estimated cost for the RI/FS at the former BHAD.

1.4 STRUCTURE OF THIS REPORT

This GSR evaluation report is structured as follows:

- Section 1: Introduction
- Section 2: Key GSR Findings
    - Review of BMPs
    - Quantitative Footprint Analysis for Planned RI Activities

    - Other Qualitative Considerations

- Section 3: GSR Recommendation

Supporting information and calculations for quantitative aspects of the evaluation are provided in appendices, and spreadsheet files for the SiteWise tool are attached electronically.

2.0 KEY GSR FINDINGS

2.1 REVIEW OF BEST MANAGEMENT PRACTICES (BMPs)

2.1.1 BMP Tables Completed by GSR Team

The GSR Team and the Project Team used a list of GSR BMPs as an outline to exchange information and ideas pertinent to application of GSR practices for this pilot project. The GSR Team subsequently completed the BMP tables included in Appendix A, based on the data provided by the Project Team in the form of documents as well as discussions during the Step 5 call. Table 2-1 summarizes information entered into the BMP tables in Appendix A, specifically with respect to the number of BMPs that appear to be applicable for this pilot project, the number of BMPs that appear to be practical for this pilot project, the number of BMPs that have been implemented prior to this GSR evaluation, and the number of BMPs that maybe associated with potential cost savings for this pilot project.

Table 2-1
Summary of BMP Applicability and Implementation from BMP Tables in Appendix A

	BMP Category								
	A. Planning	B. Characterization and/or Remedy Approach	C. Energy/Emissions Transportation	D. Energy/Emissions Equipment Use	E. Materials & Off-site Services	F. Water Resource Use	G. Waste Generation, Disposal, and Recycling	H. Land Use, Ecosystems, and Cultural Resources	I. Safety and Community
Total Number of BMPs	10	9	4	11	5	5	6	7	7
Number of Applicable BMPs	10	6	4	5	2	2	6	5	6
Number of Practical BMPs	8	6	3	3	1	2	5	5	6
Number of BMPs Implemented Prior to GSR Evaluation									
- Fully	5	5	3	3	1	2	4	5	5
- Partially	2	0	0	0	0	0	1	0	0
- Not Yet	1	1	0	0	0	0	0	0	1
Number of Practical BMPs Likely to Result in Cost Savings	3	6	3	3	1	1	1	1	0

2.1.2 Key Findings Regarding BMPs

An overview of key findings regarding application of the BMPs to this pilot project is provided below.

- The Project Team has already considered and implemented many of the GSR BMPs included in Appendix A. Although the Project Team did not explicitly consider these BMPs as part of a GSR evaluation, many of the BMPs have been considered and implemented as part of the overall process of conducting an MMRP project and/or using sound principles of science and project management. Examples of GSR BMPs already considered or incorporated include (but are not limited to) the following:

    - Scheduling activities for appropriate seasons, such as starting the intrusive work in spring which allows the dead of summer heat to be avoided to the extent possible and also reduces fire risks from the long grass.

    - Conducting a thorough review of project documents and historical records to minimize required scope of investigation, and routinely updating a conceptual site model (CSM) to use as a basis for making remedial process decisions, are inherent practices in MMRP projects.

    - Using real-time measurements, such as the use of headspace analyses for detecting CA and the use of x-rays to determine if items recovered from excavations are liquid-filled.

    - Using existing site structures/infrastructure, such as the planned use of existing igloos for the Interim Holding Facility (IHF) which eliminates the need for the construction or transportation of a temporary structure and also eliminates the need to cool that facility (since the igloos are cooled by the surrounding ground).

    - Establishing project-specific decision points, such as a plan to stop digging if appreciable quantities of CWM or MEC are found in an area during excavation work (to avoid having too much CWM or MEC to dispose of during this phase of the work).

    - Reducing the number of trips for personnel through carpooling. During the DGM task the Project Team estimated 2 vehicles for 5 staff, and during the intrusive investigation the Project Team estimated 10 vehicles for 40 staff. This represents effective carpooling.

    - Reducing trip lengths when feasible, such as using clean fill (gravel) from a local quarry and using a local source of rental for heavy equipment.

    - Minimizing engine idle times is inherent in this type of project to reduce fuel usage (i.e., cost), mitigate the potential for brush fires, and to have as little impact as possible on air monitoring conducted as part of the work.

    - Utilizing unrefined materials when possible, such as gravel from a local quarry for clean fill rather than from a more refined source.

    - Minimizing water use by limiting the amount of water for decontamination, which is inherent in a CWM project so that potential disposal of wastewater containing CA or other hazardous materials is minimized.

- Minimizing generation of waste by reusing PPE to the extent feasible.

- Segregating excavated soils to the extent that some (i.e., uncontaminated) can potentially be re-used on-site, and further segregating contaminated soil so the minimum amount possible is sent for disposal as hazardous waste.

- Recycling materials rather than disposing of them, such as plans to send recovered metal fragments that have been inspected and classified as explosive and chemical free to a recycling facility.

- Minimizing disturbance to land, such as by using airborne geophysics for BG-1 and BG-2 (which also reduces cost and the need for off-site access) and by using well-defined traffic patterns (which also minimizes potential to encounter MEC/CWM).

- Preserving/restoring ecosystems to the extent possible, such as plans to re-vegetate areas where vegetation has been disturbed with natural species to be specified by the forest service.

- Documenting sensitive ecological and cultural resources prior to initiating actions that might diminish or destroy those resources. In this case work has previously been performed to determine that there are no wetlands and no endangered species in the MRSs, and paleontology ("paleo") sites have previously been mapped.

- Contributing to the local economy, such as buying supplies and services from local vendors whenever possible (e.g., ambulance, security, water delivery, diesel delivery, equipment rental, gravel from local quarry). Also, the General Contractor for operating heavy machinery is local. Staying in local hotels and eating at restaurants during field work provides benefit to local economy.

- While going through the BMP list during the Step 5 call, the GSR Team suggested several items that the Project Team could consider moving forward. Some examples include the following:

  - *Include a section on GSR in project reports* - The GSR team recommends that the Final RI/FS Report can easily call out GSR principles that have been considered and implemented, even though such a section on GSR is not specifically included in the contractor's Task Order.

  - *Distribute documents electronically to the greatest extent possible* – It is recognized that some full hard copies are required for field team members and the information repository, but the GSR team recommends that in the future the Project Team take steps to minimize the number of hard copies (e.g., request fewer hard copies be required in the Task Order Performance Work Statement), and when possible, to reduce the size of hard copies by placing appendices and laboratory analytical data on CDs attached to the hard copies (i.e., this can possibly be done for some, if not all, of the hard copies).

  - *Recycling of plastic bottles*. There was discussion during the Step 5 call that there were some potential limitations regarding site access that may limit the practicality of recycling plastic water bottles and other consumption waste. The GSR team recommends the Project Team establish if recycling such material is practical.

- *Evaluate if Incremental Sampling Methodology (ISM) is a feasible alternative to discrete sampling for the test pits* – The Project Team explained that discrete sampling of test pit soils was planned for the MC sampling program because ISM sampling was not appropriate for subsurface soil sampling and the USACE – Omaha District already collected surface soil samples at BHAD. The GSR team recommends that ISM sampling be re-evaluated for its potential applicability to the BHAD RI/FS. The quantity of samples (i.e., 14 discrete samples per test pit plus additional discrete samples in areas with observed or potential contamination) submitted for laboratory analysis may be reduced using the ISM protocol, and/or using ISM might provide a better data set (statistically) for making remedial alternative decisions.

- The Project Team identified that some BMPs are not practical to implement because of other project-specific constraints. Examples include the following:

  - The practicality of resource sharing is limited on a CWM project. While there is a high desire to shorten field duration and/or avoid re-mobilization, there is limited ability to "dual hat" personnel roles due to the expertise required on a CWM project as well as limitations on the available work hours per employee each day and week for a CWM project (limits ability to use one person for many roles). The UXO Safety Officer (UXOSO) and UXO Quality Control Specialist (UXOQCS) roles that are typically dual hatted for a conventional MEC project must be filled separately for a CWM project, regardless of the team size.

  - The practicality of using alternate fuels for transportation is limited. The Project Team reported that they researched hybrid vehicles for personnel, but costs were prohibitive (i.e., not feasible).

  - The purchase of renewable energy certificates to offset emissions from the remedial activities is not likely to be considered practical for this project. This is a FUDS project, and costs must be kept to a minimum. Purchase of RECs would require an increase in cost.

  - Due to the specialized nature of MMRP work, the labor for the intrusive operations and geophysics must be brought to the site and performed by trained and qualified specialists (i.e., the ability to use local labor is limited).

2.2 QUANTITATIVE FOOTPRINT ANALYSIS FOR PLANNED RI ACTIVITIES (BASELINE SCENARIO)

Table 2-2 summarizes the quantitative footprint results for the current system, per year. Input to the SiteWise tool and other supporting calculations are described in Appendix B. The SiteWise files utilized for this portion of the analysis are supplied electronically (SiteWise directory "RA_Baseline_NoFR_1").

Table 2-2 divides total energy use and global warming potential into "direct" and "indirect" use and emissions. The following definitions are utilized for "direct" versus "indirect" energy use and global warming potential:

- Direct Scope 1: From sources that are owned or controlled by the reporting entity.

- Indirect Scope 2: Due to activities of the reporting entity, but occur at sources owned or controlled by another entity, from consumption of purchased electricity, heat or steam.

- Indirect Scope 3: Due to activities of the reporting entity, but occur at sources owned or controlled by another entity, other than Scope 2 (such as the extraction and production of purchased materials and fuels, transport-related activities in vehicles not owned or controlled by the reporting entity, outsourced activities, waste disposal, etc.

SiteWise reports total energy use and total global warming potential, but does not sum the "direct" and "indirect" components. The user needs to track the distinction between "direct" and "indirect" components separately, based on information contained within the SiteWise spreadsheets. The separation of the total energy and global warming potential is documented in Appendix B, which describes SiteWise input and related calculations.

Table 2-2
Summary of Quantitative Footprint for Planned RI Activities (Baseline)

GSR Parameter	Unit	Value (per year)
Environmental		
Energy – Total	MMBtu	4,116
Energy – Direct Scope 1	MMBtu	1,271
Energy – Indirect Scope 2	MMBtu	0
Energy – Indirect Scope 3	MMBtu	2,845
% of Energy from Renewable Resources	%	0.12
Global warming potential – Total	Metric tons CO2e	308
Global warming potential – Direct Scope 1	Metric tons CO2e	108
Global warming potential – Indirect Scope 2	Metric tons CO2e	5
Global warming potential – Indirect Scope 3	Metric tons CO2e	195
Criteria air pollutant emissions	Metric tons (NOx+SOx+PM)	1.43
Hazardous air pollutant emissions	Lb	none identified
Potable water use	1,000s of gallons	11.3
Other water use	1,000s of gallons	none identified
Refined materials use	Lbs	8063.3
% of refined materials from recycled material	%	0
Unrefined materials use	Ton	2,126.3
% of unrefined materials from recycled material	%	0
Non-hazardous waste generation	Ton	not quantified
Hazardous waste generation	Ton	not quantified
% of potential waste that is recycled or re-used	%	not quantified*
Land transferred or made available for beneficial use	Acres	0
Existing ecosystem destruction	Acres	0
Time frame for land re-use	Years	0
Flexibility and breadth of options for re-use	see below**	N/A for RI Phase
Economic		
Life-cycle Cost, Discounted (no discount rate assigned)***	$	$7,725,000
Life-cycle Cost, Undiscounted	$	$7,725,000
Up-front Cost	$	$7,725,000

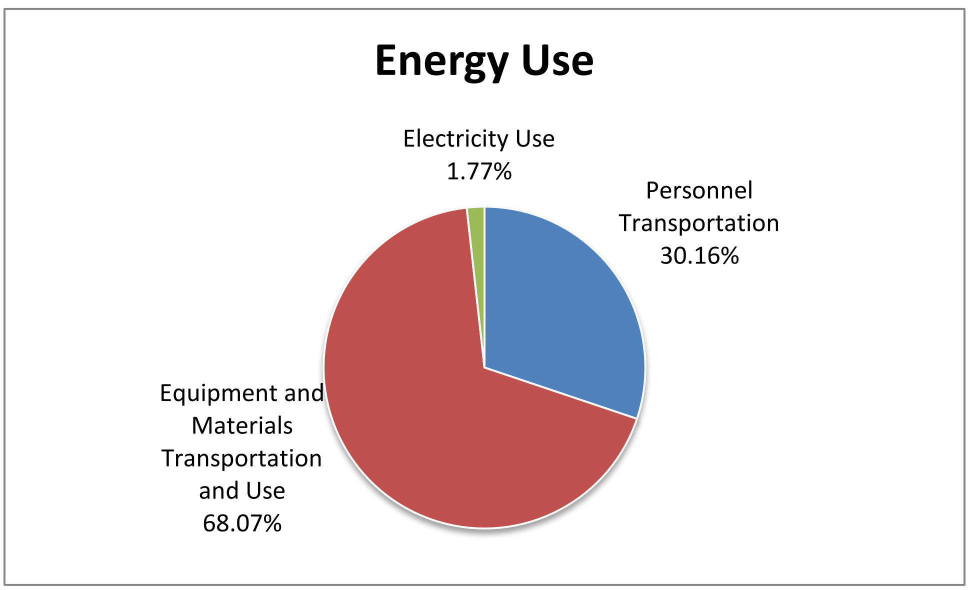
GSR Parameter	Unit	Value (per year)
Societal		
Predicted number of injuries or fatalities for On-Site Worker	Number of injuries or fatalities	0.07
Predicted number of injuries or fatalities associated with transportation	Number of injuries or fatalities	0.20
One-Way Heavy Vehicle Trips through Res. Area	Trips	0

**Cannot be determined until the RI activities are complete (e.g., amount of explosives donated to local law enforcement, soil segregated for re-use, quantity of material requiring incineration, and amount of hazardous and non-hazardous waste requiring disposal cannot be known at this time).*
***Scale for flexibility and breadth of re-use options (greater GSR value with lower number, indicating more breadth and flexibility for potential re-use)*
1 - Unlimited re-use options
2 - Limited re-use options
3 - Only one re-use option
****All of the costs are considered "up-front costs" so there is no discounting of future costs.*

2.2.1 Key Findings from Quantitative Footprint Analysis, Baseline Scenario

Observations and finding based on the quantitative footprinting results from SiteWise include the following:

- Total energy use of 4,116 MMBTUs is estimated. The primary categories for total energy use for the planned RI activities are illustrated on the graphic below and are summarized as follows:



  - The majority of the energy use (2,802 MMBTUs, or 68%) is for equipment and materials transportation and use. Of the energy associated with equipment and materials transportation and use, 1,494 MMBTUs are from equipment use, 907 MMBTUs are from production of materials, and 401 MMBTUs are from transportation of the materials and equipment.

- The helicopter used for the airborne geophysics task (already completed in summer 2011), which is a component of the "equipment and materials transportation and use", used 1200 gallons of fuel. This equates to 150 MMBTUs, and represents a small percentage of the overall energy use for the RI activities (less than 4%).

- The estimated energy use for transport of materials is approximately 400 MMBTUs, which is approximately 10% of the overall energy usage for the RI activities.

- The estimated energy use for production of materials is approximately 900 MMBTUs which is approximately 22% of the overall energy usage for the RI activities. The biggest contributor of the materials quantified was the production of the gravel for clean fill, and the next biggest contributor was the production of the geotextile fabric.

- Most of the remaining energy use is associated with the transport of personnel (30% of the total energy used). Transport via plane to bring field personnel to the local area is estimated to require approximately 614 MMBTUs, which is approximately 15% of the overall energy usage for the RI activities. The number of airplane trips, and distances for those trips, were estimated based on assumptions listed in Appendix B. It is important to note that, for MMRP projects such as this one, the specialized nature of the work limits the ability to utilize local sources of labor.

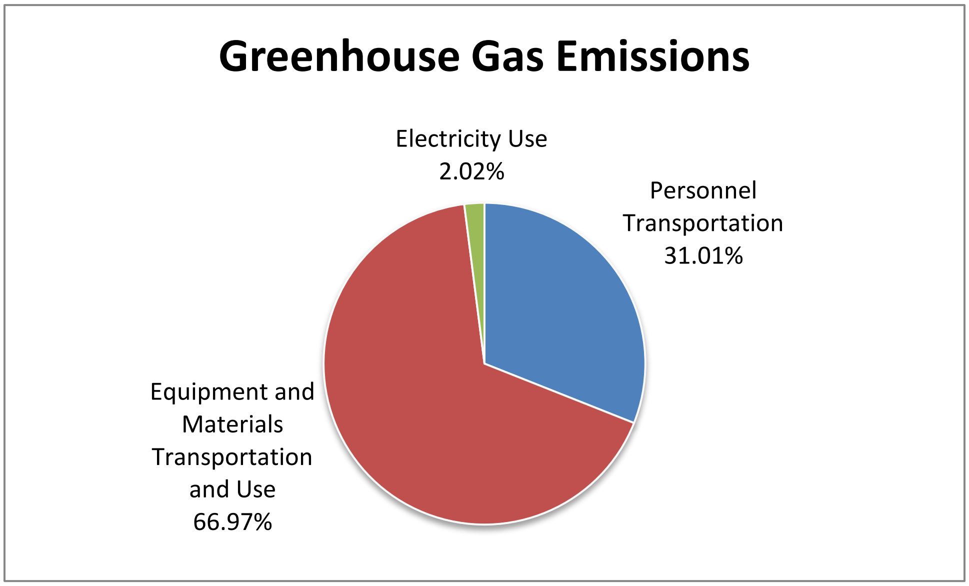
- The local carpooling of personnel from the hotels to the site trailer is estimated to require approximately 381 MMBTUs, which is approximately 9% of the overall energy usage for the RI activities. Transportation to five site meetings (combination of car trips and air trips) uses approximately 110 MMBTUs, which is less than 3% of the overall energy usage for the RI activities.

- The majority (69%) of energy use is "Indirect Scope 3", meaning it is associated with off-site energy use, and the remaining 31% of energy use is "Direct Scope 1", associated with on-site energy use. This is consistent with much of the energy use resulting from transport (of personnel, equipment, and materials) and from materials production, which are off-site energy use (i.e., "Indirect Scope 3").

- Electricity use is very minor (less than 2% of the total energy usage).

* The estimated percentage of renewable energy used is extremely small (0.12%). No on-site renewable energy generation was noted, and eGRID says that for this region of the country 8.8% of the electricity is from renewable sources. SiteWise reports that 55.84 MMBTU of the energy use is from electricity. Since the total energy use is 4,116 MMBTU, the percent of energy from renewable resources is 55.84/4,116 * 100 * 8.8% = 0.12%.

* Total GHG emissions of 308 metric tons of CO_2e are estimated. The primary categories for the greenhouse gas emissions for the planned RI activities are illustrated on the graphic below, and those categories break out in a similar manner as the energy use (described above).



- Total priority pollutants (NOx + SOx + PM) of 1.43 metric tons of CO2e are estimated. Most of the NOx emissions (79%) are associated with the use of earthwork equipment (excavator, loader, backhoe). 16% are associated with transport of personnel, equipment, and materials. The remainder, (~5%) is associated with electricity use at the IHF. The SOx and PM emissions break out in similar proportions.

- Estimated water use is equal to 11.3 thousand gallons, with 8.5 thousand gallons (75%) of that for decontamination ("decon") activities, and the remaining 25% associated with off-site electricity generation.

- The vast majority (over 99%) of the materials use that was quantified consists of unrefined material (2,126 tons of gravel). Of the 8,063 lbs (4 tons) of refined materials used, geotextile fabric accounts for the vast majority (over 99%). The only other refined material that was quantified was an estimated 31 lbs of explosives for BIP operations. Note the amount of plastic sheeting, bleach, and PPE was not quantified.

- The total number of estimated injuries/fatalities during the planned RI activities calculated by SiteWise is 0.27. Of this, 0.20 predicted injuries/fatalities are related to transportation, and only 0.07 are related to on-site activities. This is consistent with the extensive amount of travel required for field personnel at this site and the relatively small amount of on-site equipment use.

- All of the costs are considered "up-front costs" so there is no discounting of future costs. Capital costs for this project were broken out by the Project Team into the following categories:

  - USACE: $1,725,000
  - Other Government Agencies: $2,500,000
  - Contractor Task Order Award Amount: $3,500,000

2.3 QUANTITATIVE FOOTPRINT ANALYSIS FOR ALTERNATIVES

No alternatives to the planned RI activities were identified for which footprints were calculated. As mentioned earlier, footprinting could potentially be done for ISM versus discrete sampling in test pits, though this would require the amount of ISM sampling to be specified.

2.4 OTHER QUALITATIVE CONSIDERATIONS

None.

3.0 GSR RECOMMENDATIONS

Recommendations are provided by the GSR Team for the consideration of the Project Team, and potentially other project stakeholders. These are not requirements, and implementation should ultimately be decided by the Project Team based on their concurrence regarding GSR benefits and/or other project-specific constraints.

The RI/FS activities have been planned in a manner such that that many GSR considerations are already addressed as part of the overall process of conducting an MMRP project, and/or addresses by using sound principles of science and project management. No alternatives were identified to the planned activities that included footprint quantification within this GSR evaluation. The GSR team offers the following recommendations regarding GSR considerations that are summarized in the form of tracking tables, as follows:

Table Number	**Recommendation**
3-1	Include a section on GSR in project reports
3-2	Distribute documents electronically to the greatest extent possible
3-3	Recycling of plastic bottles
3-4	Evaluate if Incremental Sampling Methodology (ISM) is a feasible alternative to discrete sampling for the test pits

The tracking table format allows the implementation status of the recommendation to be updated as the project progresses.

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Table 3-1
Tracking Table for Recommendation 3.1

<table>
<tr><td colspan="2" rowspan="2">Recommendation:

3.1 - Include a section on GSR in project reports.</td><td>Current Date:
1/12/12</td></tr>
<tr><td>Date of Original Recommendation:
1/12/12</td></tr>
<tr><td colspan="3">Basis for Recommendation (Include discussion of cost impacts and value if appropriate):

The GSR team recommends that the final RI/FS report can easily call out GSR principles that have been considered and implemented, even though such a section on GSR is not specifically included in the contractor's Task Order.</td></tr>
<tr><td colspan="3">Resources Conserved:
☐ Hazardous air pollutants ☐ GHG emissions (CO2e) ☐ Energy ☐ Water ☐ Waste
☐ Criteria pollutants ☐ Safety/Community ☐ Materials ☐ Land-use</td></tr>
<tr><td colspan="2">Qualitative Net Cost Impact Over 5 Years, No Discounting

☐ Cost Increase ☐ Cost Savings
☒ Cost Neutral ☐ N/A</td><td>☐ Recommended action otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="3">Attachment(s) to report with footprint assumptions and calculations:

This is a qualitative recommendation, and no detailed footprinting was performed.</td></tr>
<tr><td>Implementation Status:

☐ Fully
☐ Partially
☒ Not Yet
☐ Not Planned</td><td colspan="2">Explanation of Status:

This is a new recommendation for the Project Team to consider. Although this recommendation does not specifically have a direct impact on any conserving resources, it can highlight activities (past or present) that conserve resources.</td></tr>
</table>

Table 3-2
Tracking Table for Recommendation 3.2

<table>
<tr><td colspan="3">Recommendation:

3.2 - Distribute documents electronically to the greatest extent possible</td><td>Current Date:
1/12/12

Date of Original Recommendation:
1/12/12</td></tr>
<tr><td colspan="4">Basis for Recommendation (Include discussion of cost impacts and value if appropriate):

It is recognized that some full hard copies are required for field team members and the information repository, but the GSR team recommends that in the future the Project Team take steps to minimize the number of hard copies (e.g., request fewer hard copies be required in the Task Order Performance Work Statement), and when possible, to reduce the size of hard copies by placing appendices and laboratory analytical data on CDs attached to the hard copies (i.e., this can possibly be done for some, if not all, of the hard copies). The Project Team already utilizes electronic deliverables, and the recommendation is to attempt to further reduce the amount paper used for hard copies which reduces paper use, reduces size of documents for storing, reduces weight of documents for shipping, etc.</td></tr>
<tr><td colspan="4">Resources Conserved:
☒ Hazardous air pollutants ☒ GHG emissions (CO2e) ☒ Energy ☐ Water ☒ Waste
☒ Criteria pollutants ☐ Safety/Community ☒ Materials ☐ Land-use</td></tr>
<tr><td colspan="2">Qualitative Net Cost Impact Over 5 Years, No Discounting

☐ Cost Increase ☐ Cost Savings
☒ Cost Neutral ☐ N/A</td><td colspan="2">☐ Recommended action otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="4">Attachment(s) to report with footprint assumptions and calculations:

This is a qualitative recommendation, and no detailed footprinting was performed.</td></tr>
<tr><td>Implementation Status:

☐ Fully
☒ Partially
☐ Not Yet
☐ Not Planned</td><td colspan="3">Explanation of Status:

This is a new recommendation for the Project Team to consider. "Partially" is checked to acknowledge that the Project Team already utilizes electronic deliverables. The recommendation is to attempt to further reduce hard copies.</td></tr>
</table>

Table 3-3
Tracking Table for Recommendation 3.3

<table>
<tr><td colspan="2" rowspan="2">Recommendation:

3.3 - Recycling of plastic bottles.</td><td>Current Date:
1/12/12</td></tr>
<tr><td>Date of Original Recommendation:
1/12/12</td></tr>
<tr><td colspan="3">Basis for Recommendation (Include discussion of cost impacts and value if appropriate):

There was discussion during the Step 5 call that there were some potential limitations regarding site access that may limit the practicality of recycling plastic water bottles and other consumption waste. The GSR team recommends the Project Team establish if recycling such material is practical.</td></tr>
<tr><td colspan="3">Resources Conserved:
☐ Hazardous air pollutants ☐ GHG emissions (CO2e) ☐ Energy ☐ Water ☒ Waste
☐ Criteria pollutants ☐ Safety/Community ☐ Materials ☐ Land-use</td></tr>
<tr><td colspan="2">Qualitative Net Cost Impact Over 5 Years, No Discounting
☐ Cost Increase ☐ Cost Savings
☒ Cost Neutral ☐ N/A</td><td>☐ Recommended action otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="3">Attachment(s) to report with footprint assumptions and calculations:

This is a qualitative recommendation, and no detailed footprinting was performed.</td></tr>
<tr><td>Implementation Status:

☐ Fully
☐ Partially
☒ Not Yet
☐ Not Planned</td><td colspan="2">Explanation of Status:

This is a new recommendation for the Project Team to consider.</td></tr>
</table>

Table 3-4
Tracking Table for Recommendation 3.4

<table>
<tr><td colspan="2" rowspan="2">Recommendation:

3.4 - Evaluate if Incremental Sampling Methodology (ISM) is a feasible alternative to discrete sampling for the test pits.</td><td>Current Date:
1/12/12</td></tr>
<tr><td>Date of Original Recommendation:
1/12/12</td></tr>
<tr><td colspan="3">Basis for Recommendation (Include discussion of cost impacts and value if appropriate):

The Project Team explained that discrete sampling of test pit soils was planned for the MC sampling program because ISM sampling was not appropriate for subsurface soil sampling and the USACE – Omaha District already collected surface soil samples at BHAD. The GSR team recommends that ISM sampling be re-evaluated for its potential applicability to the BHAD RI/FS. The quantity of samples (i.e., 14 discrete samples per test pit plus additional discrete samples in areas with observed or potential contamination) submitted for laboratory analysis may be reduced using the ISM protocol, and/or using ISM might provide a better data set (statistically) for making remedial alternative decisions.</td></tr>
<tr><td colspan="3">Resources Conserved:
☐ Hazardous air pollutants ☐ GHG emissions (CO2e) ☐ Energy ☐ Water ☐ Waste
☐ Criteria pollutants ☐ Safety/Community ☐ Materials ☐ Land-use</td></tr>
<tr><td>Qualitative Net Cost Impact Over 5 Years, No Discounting

☐ Cost Increase ☐ Cost Savings
☐ Cost Neutral ☐ N/A</td><td colspan="2">☐ Recommended action otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="3">Attachment(s) to report with footprint assumptions and calculations:

This is a qualitative recommendation, and no detailed footprinting was performed.</td></tr>
<tr><td>Implementation Status:

☐ Fully
☐ Partially
☒ Not Yet
☐ Not Planned</td><td colspan="2">Explanation of Status:

This is a new recommendation for the Project Team to consider. The extent to which resources might be conserved and the relative change in costs of ISM versus the discrete sampling were not determined by the GSR team (such an evaluation would require that the number of ISM samples be specified).</td></tr>
</table>

FIGURES

Figure 1-1. Location of the three MRSs at the Former BHAD

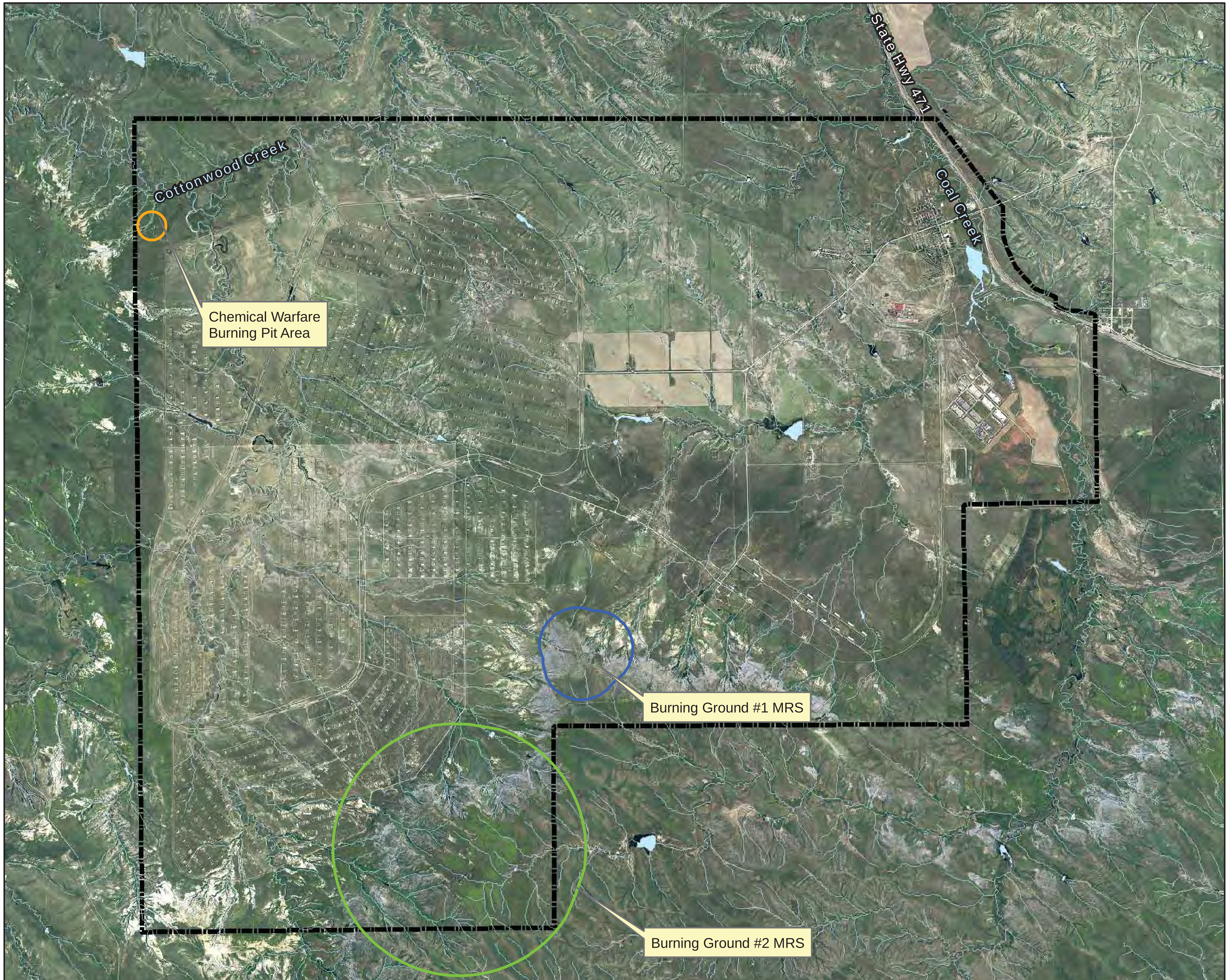

Figure 1.2

Munitions Response Site Overview
Formerly Used Defense Site
Black Hills Army Depot
FUDS Project # B08SD000800
Black Hills, SD

Legend

- Burning Ground No. 1 (220 acres)
- Burning Ground No. 2 (1,627 acres)
- Chemical Warfare Burning Pit Area (21 acres)
- Approximate BHAD Boundary

MRS boundaries are shown as indicated in the Annual Report to Congress. Figure dated 2003 (http://deparc.xservices.com/do/mmrp)

N

Image Source: Orthophoto 2010
Projection: NAD_1983_UTM_Zone_13N

Feet
3,000 1,500 0 3,000

PARSONS	U.S. ARMY ENGINEERING & SUPPORT CENTER HUNTSVILLE, ALABAMA

DESIGNED BY: CR	Former Black Hills Army Depot	
DRAWN BY: CR		
CHECKED BY: CtB	SCALE: As Shown	PROJECT NUMBER: 747769
SUBMITTED BY: GN	DATE: April 2011	PAGE NUMBER:
	FILE: S:\ES\shared\S:\ES\shared\Black Hills \GIS\work plan\BHAD_MRS_overview.mxd	

APPENDIX A

Best Management Practice (BMP) Tables

BMP Category A: Planning

BMP A-1: Develop a culture of GSR within the Project Team and encourage GSR ideas from project staff	**Date:** 1/12/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☒ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

GSR has not been called out specifically during project planning and execution, but GSR concepts are inherent in the way MMRP projects are conducted. An example is the way the airborne geophysics technology was considered and implemented, to try to maximize information generated while balancing the required number of people and time in the field as well as reducing the need for access (i.e., disturbance to community), etc.

BMP A-2: Incorporate a section on GSR in project meetings, work plans, and reports	**Date:** 1/12/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☒ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☒ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Sections on GSR have not specifically been included in work plans and reports to date. The GSR team recommended that the final RI/FS report can easily call out GSR principles that have been considered and implemented (that will be documented in this GSR report), even though such a section on GSR is not specifically included in the contractor's Task Order.

BMP A-3: Identify and periodically update a list of key stakeholders and their concerns with respect to GSR considerations

Date: 1/12/12

☒ Applicable

☒ Evaluated

☒ Practical

Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☒ Partially ☐ Not Yet ☐ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☐ Economic ☒ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☒ Hazardous air pollutants ☒ Energy ☒ Waste
☒ Criteria pollutants ☒ Materials ☒ Safety/Community
☒ GHG emissions (CO2e) ☒ Water ☒ Land-use

☐ BMP otherwise required?
If checked, required by:

There are very few nearby residences. There are regular TPP meetings. The community is notified by fact sheets, and there will be a press release regarding the intrusive work, along with a community information session of some type. That will be a good opportunity to specifically ask if there are any sustainability concerns in the community. There is a list of key stakeholders. Regulators (part of the list of stakeholders) have not specifically brought up GSR concerns. The Forest service has expressed concerns about paleo resources (it is not believed those will be adversely affected by the planned RI/FS activities).

BMP A-4: Schedule activities for appropriate seasons and/or time of day to reduce delays caused by weather conditions and fuel needed for heating or cooling

Examples:

- Work at night in summer to avoid heat stress
- Perform field activities in summer to take advantage of longer daylight

Date: 1/12/12

☒ Applicable

☒ Evaluated

☒ Practical

Implemented?
("N/A" if "Practical" not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☐ Economic ☒ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☒ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

The intrusive work, which is scheduled for spring/summer 2012 and is expected to last 3 to 4 months, does consider heat and fire potential with respect to scheduling. It is better to start early enough in spring to avoid summer heat, and grass is a greater fire hazard in the dead of summer. It was stated during the Step 5 call that intrusive work is limited to 40 hrs/wk so the longer days in summer do not provide a significant advantage. It was also stated that although working in dead of summer is less preferable, work that starts in spring will continue into summer (i.e., will not break and then re-mobilize).

BMP A-5: Prepare, store, and distribute documents electronically	**Date:** 1/12/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☒ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☐ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Hard copies are driven by scope and the need for people in the field to have hard copies. Paper is recycled. It was discussed that perhaps a project website could remove need for some hard copies, but it was noted during the Step 5 call that many of the locals do not have computers. The GSR team recommends that in the future the Project Team take steps to minimize the number of hard copies (e.g., request fewer hard copies be required), and when possible, to reduce the size of hard copies by placing appendices and lab data on CDs attached to the card copies (i.e., maybe this can be done for some, if not all, of the hard copies).*	

BMP A-6: Utilize teleconferences rather than meetings when feasible	**Date:** 1/12/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP is already being implemented to the extent possible. There is some need for some in-person meetings such as TPP meetings, and these are typically held in Pierre to accommodate the State regulator. To the extent possible calls are used in place of meetings (e.g., there are numerous calls with regulators rather than in-person meetings).*	

BMP A-7: Incorporate green specifications into solicitations and contracts Examples: - Follow pertinent green procurement policies - Select hotel chains with "green" policies - Select laboratories that utilize renewable energy	**Date:** 1/12/12 ☒ Applicable ☒ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☒ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Not clear if this is practical - It was stated during the Step 5 call that this would need to be in the "DID" to do this in future contracts. Difficult to justify if it leads to higher costs.*	

BMP A-8: Integrate schedules to allow for resource sharing and fewer days of field mobilization	**Date:** 1/12/12 ☒ Applicable ☒ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☐ Waste ☒ Criteria pollutants ☐ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Practicality of resource sharing is limited on a CWM job. While there is a high desire to shorten duration and/or avoid re-mobilization, there is limited ability to "dual hat" due to the expertise required on a CWM job as well as limitations on the available work hours per employee each day and week for a CWM job (limits ability to use one person for many roles).*	

BMP A-9: Explore multiple site re-use options, including those that include some restriction of site re-use and related resource conservation	**Date:** 1/12/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☒ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☒ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Inherent in the RI/FS process for this site is a determination of land uses acceptable to regulators and stakeholders, and to identify and address land use restrictions placed by the Forest Service. Decisions regarding future land use and land use controls will be based on regulator and stakeholder input throughout the RI/FS process.*	

BMP A-10: Conduct thorough review of project documents and historical records to minimize required scope of investigation Examples: - IRP projects: determine if there are previous aquifer tests that can be used for groundwater modeling rather than conducting new aquifer tests - MMRP projects: perform careful review of historic documents, aerial photographs, and other existing information to reduce the footprint of land that needs to be disturbed for thorough investigation and remediation - MMRP projects: use IRP sampling data to supplement and enhance the MMRP field program (if available)	**Date:** 1/12/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This is inherent in all MMRP projects, and serves to limit the extent of the area being investigated.*	

BMP Category B: Characterization and/or Remedy Approach

BMP B-1: Develop and routinely update a conceptual site model (CSM) to use as a basis for making remedial process decisions		**Date:** 1/12/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A	
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000	
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☒ Land-use	☐ BMP otherwise required? If checked, required by:	
Notes (including discussion of possible value of implementing the BMP): *The CMS is described in the work plan, and is a key to the MMRP process. An example is the discussion in the work plan regarding the lack of a need investigate for MC in groundwater since there is no real potable water untila depth of approximately 6,000 ft (i.e., incomplete exposure pathway).*		

BMP B-2: Perform frequent optimization evaluations to improve efficiency of current or planned actions and/or develop alternative remedial approaches that might shorten remedy duration or otherwise improve the net environmental benefit of the remedy		**Date:** 1/12/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☒ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A	
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000	
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☒ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:	
Notes (including discussion of possible value of implementing the BMP): *There is a form of optimization being performed by the nature of the phasing – first geophysics are performed to identify anomalies, followed by intrusive investigations where there are anomalies. This is preferable to random test pits.* *Doing this intrusive investigation can then lead to "optimization" within the approach determined for the subsequent remediation phase.*		

BMP Category B: Characterization and/or Remedy Approach

BMP B-3: Use appropriate characterization or remedy approach based on site conditions Examples: - Consider in-situ and passive remedy options that offer adequate protectiveness - Consider in-situ bioremediation if conditions are already anaerobic and constituents are conducive to reductive dechlorination - Compare source removal versus in-situ and ex-situ remedial options - Consider different technologies for impacted areas with higher and lower concentrations - Use realistic times to remedy closeout (i.e., estimations through modeling) rather than assumed remedy timeframes (e.g., 30 years), which is often used for evaluation of FS alternatives - MMRP projects: evaluate man-portable DGM instruments versus vehicle-towed array (VTA) instruments and inclusion of detector-aided reconnaissance (DAR)	**Date:** 1/12/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *An example is the use of airborne geophysics on BG-1 and BG-2 which are large areas, one of which (BG-2) extends off-site. Airborne geophysics works here because a very high percentage of the ground surface is generally conducive to airborne geophysics, and it avoids the need for access to the off-site areas that airborne geophysics can address. It is not clear if the energy use and associated emissions are higher or lower, but the man-hours needed in the field were certainly reduced significantly.*	

BMP B-4: Establish decision points to trigger a change from one technology to another or from one remedy alternative to another Examples: - Change vapor treatment from thermal oxidation to granular activated carbon (GAC) media based on flow rates and concentrations - Remove a treatment polishing step if influent to that step already meets discharge criteria - Move to Monitored Natural Attenuation (MNA) if specific concentration thresholds in groundwater are met	**Date:** 1/12/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *No real applicability for this BMP identified by GSR team.*	

BMP Category B: Characterization and/or Remedy Approach

<table>
<tr><td colspan="3">BMP B-5: Focus sampling efforts to meet objectives of the specific remedial phase (e.g., sampling during O&M should be focused on evaluating remedy performance and not on thorough plume characterization)
Examples:
- Eliminate sampling parameters as appropriate
- Reduce sampling frequency as appropriate
- Reduce sample locations as appropriate
- Enhance monitoring program as appropriate
- MMRP projects: consider Incremental Sampling Methodology (ISM) versus discrete sampling for MC characterization</td><td>Date: 1/12/12

☐ Applicable
☐ Evaluated
☐ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☐ Fully ☐ Partially ☐ Not Yet ☐ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social</td><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
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☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="2">Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

No real applicability for this BMP identified by GSR team. ISM sampling does not apply to this site – would apply more to a “range” type of site where surface contamination was the issue.</td></tr>
</table>

BMP Category B: Characterization and/or Remedy Approach

<table>
<tr><td colspan="3">BMP B-6: Consider real-time measurements and dynamic work plans to reduce mobilizations and improve effectiveness of investigation efforts
Examples:
- Field test kits (e.g., test kits for sulfate)
- Field screening instruments (e.g., x-ray fluorescence for lead or photoionization detectors for volatile organics)
- Drive point sensor technologies (e.g., membrane interface probe or “MIP”)
- Visual staining or odor
- Establish excavation extent based on real-time data collected as excavation proceeds and use GPS to accurately delineate excavation areas
- MMRP projects: use GPS and/or the same equipment that was used for detection to confirm anomaly signatures prior to excavating
- MMRP projects: consider incorporating field screening methods (e.g., X-ray fluorescence, EXPRAY and explosives test kits, as appropriate or applicable) into the field program to refine sampling locations and reduce the quantities of samples submitted for off-site laboratory analysis</td><td>Date: 1/12/12

☒ Applicable
☒ Evaluated
☒ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☒ Economic ☐ Social</td><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="2">Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

It was stated during the Step 5 call that sampling during intrusive investigations will be based on real-time air monitoring. Once test pits are open, it will be determined if chemical agents are present based on headspace results. Also, real-time x-rays will be used to determine if items recovered from excavations are liquid-filled.</td></tr>
</table>

BMP Category B: Characterization and/or Remedy Approach

BMP B-7: Consider use of existing site structures/infrastructure or mobilization of temporary structures versus new construction

Examples:

- Buildings (e.g., for treatment building or field office)
- Concrete slabs or foundations
- Wells
- Existing excavations for storm water control

Date: 1/12/12

☒ Applicable

☒ Evaluated

☒ Practical

Implemented?
("N/A" if "Practical" not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☒ Economic ☒ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☐ Hazardous air pollutants ☒ Energy ☒ Waste
☒ Criteria pollutants ☒ Materials ☒ Safety/Community
☒ GHG emissions (CO2e) ☐ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

An excellent example is the use of existing igloos for the Interim Holding Facility (IHF) for storing recovered CWM. Not only does this use an existing structure, but also precludes use of power that would be needed for climate control to a temporary IHF structure.

BMP B-8: Establish project-specific decision points to limit extent of remediation

Examples:

- Project-specific cleanup levels based on a site-specific risk assessment (coordinated with risk assessment experts) rather than generic cleanup levels, if it results in lower footprints for key parameters and is acceptable to all stakeholders
- MMRP projects: dig stopping rules and anomaly prioritization/detection criteria to minimize false positives

Date: 1/12/12

☒ Applicable

☒ Evaluated

☒ Practical

Implemented?
("N/A" if "Practical" not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☒ Economic ☒ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☐ Hazardous air pollutants ☒ Energy ☒ Waste
☒ Criteria pollutants ☒ Materials ☒ Safety/Community
☒ GHG emissions (CO2e) ☐ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

This BMP is an important consideration during the RI/FS phase that is focused on characterization. If a lot of CWM or MEC is found in an area the excavation will not continue, and rather will be left for the remediation phase. This will avoid having too much CWM or MEC to dispose of during this phase of the work.

BMP Category B: Characterization and/or Remedy Approach

<table>
<tr><td colspan="3">BMP B-9: Consider leaving in place structures whose removal is not necessary (i.e., foundations, underground pillars, etc.)</td><td>Date: 1/12/12
☐ Applicable
☐ Evaluated
☐ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social</td><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="2">Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

This BMP is not applicable for this project, since no structures will be removed other than a fence.</td></tr>
</table>

BMP Category C: Energy/Emissions – Transportation

BMP C-1: Reduce the number of trips for personnel Examples: - Encourage carpooling - Use telemetry systems and webcams to remotely transmit data directly to project offices to avoid trips	**Date:** 1/12/12 ☒ Applicable ☒ Evaluated ☒ Practical

Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < \$10,000 ☐ \$10,001 - \$50,000 ☐ \$50,001 - \$100,000 ☐ \$100,001 - \$500,000 ☐ > \$500,000
Resources Conserved: ☐ Hazardous air pollutants ☒ Energy ☐ Waste ☒ Criteria pollutants ☐ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

There will be carpooling from the hotel to the site trailer. During the DGM task the Project Team estimated 2 vehicles for 5 staff, and during the intrusive investigation the Project Team estimated 10 vehicles for 40 staff. This represents effective carpooling. ATV's and an ambulance will be kept on site during intrusive investigations to limit the back-and-forth transport from off-site.

BMP C-2: Reduce the number of trips and/or volume for transported materials, equipment, or waste Examples: - Transfer full loads by consolidating shipments from vendors and/or shipments to disposal sites (also share shipments with neighbors if feasible) - Purchase more concentrated chemicals to reduce transportation weight and/or volume	**Date:** 1/12/12 ☒ Applicable ☒ Evaluated ☒ Practical

Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < \$10,000 ☐ \$10,001 - \$50,000 ☐ \$50,001 - \$100,000 ☐ \$100,001 - \$500,000 ☐ > \$500,000
Resources Conserved: ☐ Hazardous air pollutants ☒ Energy ☐ Waste ☒ Criteria pollutants ☐ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

An example is the plan to terminate digging during this phase in highly contaminated areas (once they are discovered) to avoid extensive waste disposal requirements during this phase of the work.

Also, scrap metal collected during the RI/FS will be stockpiled and then removed at the end of field activities for recycling – this approach will tend to create a "full load" rather than many small loads.

BMP Category C: Energy/Emissions – Transportation

BMP C-3: Reduce trip lengths Examples: - Dispose of waste at closest appropriate facility - Purchase materials, equipment, and services from local vendors - Use locally produced supplies - Select most efficient transportation route	**Date:** 1/12/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☒ Energy ☐ Waste ☒ Criteria pollutants ☐ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Using local source for clean fill (gravel), likely within 15 miles.* *Local source of rental for heavy equipment. No armored vehicles expected to be needed.* *There are very limited options for disposal of waste that results from decontamination of CWM.*	

BMP C-4: Use alternate fuels or other options for transportation when possible Examples: - Compressed natural gas - Biodiesel blends - Ethanol blends - Hybrid and/or electric - Rail lines versus trucks - Use a fuel efficient passenger car rather than a pickup truck if task allows	**Date:** 1/12/12 ☒ Applicable ☒ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☒ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☒ Energy ☐ Waste ☒ Criteria pollutants ☐ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Project Team reports they researched hybrid vehicles for personnel, but costs were prohibitive (i.e., not feasible). The level of up-front cost impact was not quantified.*	

BMP Category D: Energy/Emissions – Equipment Use

BMP D-1: Consider and implement approaches to minimize engine idle times	**Date:** 1/12/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☒ Energy ☐ Waste ☒ Criteria pollutants ☐ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This is inherent in this type of project to reduce cost for fuel, mitigate the potential for brush fires, and to have as little impact as possible on air monitoring conducted as part of the work.*	

BMP D-2: Ensure peak operating efficiency of equipment to reduce energy use and emissions Examples: - Perform preventative maintenance and operate equipment per manufacturer instructions - Perform retrofits involving low-maintenance multi-stage filters for cleaner engine exhaust - Use synthetic oil to extend operating life (and reduce waste oil) - Purchase newer equipment with reduced emissions	**Date:** 1/12/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☒ Energy ☐ Waste ☒ Criteria pollutants ☐ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *The project team plans to make sure local equipment rental is provided in peak operating condition.*	

BMP Category D: Energy/Emissions – Equipment Use

BMP D-3: Use alternate fuel options for equipment when possible Examples: - Compressed natural gas - Biodiesel - Ethanol blends - Ultra-low sulfur diesel, wherever available (and as required by engines with PM traps)	**Date:** 1/12/12 ☒ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☒ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Has not been fully evaluated but was not identified as a major concern for this Project Team.*	

BMP D-4: Select appropriate equipment and/or power source for the job Examples: - Avoid using large excavators for small earthmoving projects - Use direct push methods when possible to reduce drilling duration - Compare potential use of electricity versus battery versus generator	**Date:** 1/12/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *One example was determining that existing igloos could be used for the IHF, which would not require the need for cooling.*	

BMP Category D: Energy/Emissions – Equipment Use

BMP D-5: Use variable frequency drives on motors (e.g., pumps, blowers), or replace oversized motors with properly sized motors	**Date:** 1/12/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☒ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP is not applicable for this project, since no pumps, blowers, or similar equipment will be used.*	

BMP D-6: Identify options for generating renewable energy for direct use in the remedy and/or for alternate use at or near the project site Examples: - Solar, wind, landfill gas (microturbines), combined heat and power, geothermal heat exchange - Applications for remote areas such as solar pumps or solar flares (if demand is not continuous, the need for a battery backup may be avoided) - Generate power or heat exchange from water to be discharged	**Date:** 1/12/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☒ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Very little energy will be used for this short-term project, so this is not really applicable.*	

BMP Category D: Energy/Emissions – Equipment Use

BMP D-7: Consider purchase of renewable energy certificates to offset emissions from the remedial activities

Date: 1/12/12

☒ Applicable
☒ Evaluated
☐ Practical

Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☒ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

This is not likely to be considered practical for this project. This is a FUDS project, and costs must be kept to a minimum. Purchase of RECs would require an increase in cost.

BMP D-8: Design/modify housing required for above-ground treatment components for energy-efficiency

Examples:

- Passive lighting
- Compact fluorescent lighting (CFL) or light-emitting diode (LD) lighting
- Timers and/or motion control sensors for lighting
- Shading
- Minimize heating and cooling needs (building size, insulation, etc.)

Date: 1/12/12

☐ Applicable
☐ Evaluated
☐ Practical

Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☒ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

This BMP is not applicable for this remedy, since there is no long-term above-ground treatment component.

BMP Category D: Energy/Emissions – Equipment Use

<table>
<tr><td colspan="2">BMP D-9: For remedies that involve groundwater or air extraction, optimize extraction to reduce flow rates (potentially beneficial with respect to energy use, materials usage, water resources, waste disposal, etc.)</td><td>Date: 1/12/12
☐ Applicable
☐ Evaluated
☐ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A</td><td colspan="2">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☒ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social</td><td colspan="2">Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td>Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Notes (including discussion of possible value of implementing the BMP):

This BMP is not applicable for this project.</td></tr>
</table>

<table>
<tr><td colspan="2">BMP D-10: Consider pulsing for extraction of water or air to maximize mass removal per unit of time or energy, by extracting higher concentrations</td><td>Date: 1/12/12
☐ Applicable
☐ Evaluated
☐ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A</td><td colspan="2">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☒ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social</td><td colspan="2">Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td>Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Notes (including discussion of possible value of implementing the BMP):

This BMP is not applicable for this project.</td></tr>
</table>

<table>
<tr><td colspan="2">BMP D-11: Run electrical equipment during times of lower electric demand if possible (this does not reduce energy use but could lower cost and also can lower stress on the energy grid during periods of peak demand)</td><td>Date: 1/12/12
☐ Applicable
☐ Evaluated
☐ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A</td><td colspan="2">Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☒ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social</td><td colspan="2">Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td>Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Notes (including discussion of possible value of implementing the BMP):

This BMP is not applicable for this project.</td></tr>
</table>

BMP Category E: Materials & Off-Site Services

BMP E-1: Use materials that are made from recycled materials Examples: - Steel - Asphalt - Plastics - Concrete	**Date:** 1/12/12 ☒ Applicable ☒ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☒ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *No significant materials were identified that can be obtained from recycled materials. The primary materials are clean fill (gravel), geo-cloth for excavations, fencing, decon water and bleach.*	

BMP E-2: Optimize the amount of materials used Examples: - Experiment with different material amounts/doses - Consider alternate materials - Use timers or feedback loops and process controls for dosing - MMRP projects: minimize quantities of donor explosives for MEC destruction	**Date:** 1/12/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☒ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Very few materials are being used, so this does not really apply.* *MEC will be exploded daily to minimize risks.*	

BMP E-3: Utilize less refined materials when feasible

Examples:

- Limestone instead of sodium hydroxide for pH adjustment
- Native fill instead of select fill

Date: 1/12/12

☒ Applicable

☒ Evaluated

☒ Practical

Implemented? (“N/A” if “Practical” not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☐ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☒ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

A local quarry will be utilized for clean fill (un-refined) rather than purchased as refined material.

BMP E-4: Identify opportunities for using by-products or “waste” materials from local sources in place of refined chemicals or materials

Examples:

- Cheese whey, molasses, compost, or off-spec food products for inducing anaerobic conditions
- Crushed concrete for use as fill
- Concrete from coal combustion byproducts

Date: 1/12/12

☐ Applicable

☐ Evaluated

☐ Practical

Implemented?
(“N/A” if “Practical” not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☒ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Generally does not apply to the materials need for this project, though the possibility of using manure from cows or buffalo as fertilizer for re-seeding was raised.

BMP E-5: Reduce demand on Publicly Owned Treatment Works (POTWs) Examples: - Discharge treated water to groundwater or to surface water rather than POTW - Minimize amount of water requiring treatment	**Date:** 1/12/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☒ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP is not applicable for this project, since no water is sent to a POTW.*	

BMP Category F: Water Resource Use

BMP F-1: Minimize water consumption
Examples:
- Sensors to turn off water when not needed
- Low flow fittings
- Minimize water needs for irrigation (landscape choices, use of mats and mulch)

Date: 1/12/12
☒ Applicable
☒ Evaluated
☒ Practical

Implemented?
("N/A" if "Practical" not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☒ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☒ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

This applies to the amount of water used for decon. Minimizing this use is inherent for this project because it avoids waste, which is of paramount importance for a CWM project due to the large expense of waste disposal.

BMP F-2: Preferentially use less refined water resources when feasible
Examples:
- Use extracted groundwater instead of potable water for chemical blending
- Capture and store rain/storm water for future use
- Employ rumble grates with a closed-loop gray-water washing system

Date: 1/12/12
☐ Applicable
☐ Evaluated
☐ Practical

Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☒ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Not really applicable to this project.

BMP Category F: Water Resource Use

BMP F-3: Use extracted and treated water for beneficial purposes Examples: - Irrigation - Potable water - Industrial process water	**Date:** 1/12/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☒ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *No water extraction is associated with this project.*	

BMP F-4: Promote groundwater recharge Examples: - Recharge extracted and treated water when beneficial uses of the water are not identified and reinjection is practical - Minimize site area covered by impervious surfaces to reduce runoff and maximize infiltration (unless such capping is a specific component of the remedial action)	**Date:** 1/12/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☒ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Does not apply to this project.*	

BMP Category F: Water Resource Use

<table>
<tr><td colspan="3">BMP F-5: Maintain water quality by preventing nutrient loading to surface water or groundwater
Examples:
- Use phosphate-free detergents instead of organic solvents or acids to decontaminate sampling equipment (if not required for some contaminants)</td><td>Date: 1/12/12
☒ Applicable
☒ Evaluated
☒ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☐ Economic ☐ Social</td><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="2">Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☒ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

All decon water will be collected (i.e.,, no runoff). There will be just a small amount of fertilizer used for re-seeding.</td></tr>
</table>

BMP Category G: Waste Generation, Disposal, and Recycling

BMP G-1: Minimize drill cuttings and all other investigation derived waste (including personal protection equipment) Examples: - Direct push or sonic drilling to reduce drill cuttings - Low-flow sampling or passive diffusion bags (if applicable) to reduce purge water - When possible place drill cuttings on-site rather than off-site disposal	**Date:** 1/12/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☒ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☒ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *It is particularly important to minimize all types of waste during a CWM project due to the potential large cost for waste disposal. It was stated during the Step 5 call that, to the extent feasible, PPE will be reused. Tyvek can be used for a full day, and CPUs can potentially be used for up to 7 days. This will reduce the amount of waste that needs to be disposed. It was also stated that excavated material will be analyzed, and when feasible put back into the excavations. Also, when large amounts of contamination are identified digging will stop, to minimize waste disposal during this phase (such contamination would then be dealt with in the remediation phase).*	

BMP G-2: Segregate excavated soil in pre-planned staging areas so that "clean" material can be deposited on-site and/or re-used rather than transported for off-site disposal	**Date:** 1/12/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☒ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☒ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Wastes will be segregated to minimize disposal.*	

BMP Category G: Waste Generation, Disposal, and Recycling

BMP G-3: Consider on-site treatment and re-use of soil instead of off-site disposal
Examples:
- Land farming
- Above ground soil vapor extraction (SVE)

Date: 1/12/12
☒ Applicable
☐ Evaluated
☐ Practical

Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☒ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

This is potentially applicable if the RI/FS generates soil that would require removal. It will be evaluated if the RI/FS produces such soils.

BMP G-4: Minimize need to transport and dispose hazardous waste
Examples:
- Consider delisting listed hazardous waste if waste is not characteristically hazardous waste
- Segregate hazardous waste and non-hazardous waste

Date: 1/12/12
☒ Applicable
☒ Evaluated
☒ Practical

Implemented? ("N/A" if "Practical" not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☒ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☒ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Again, this is implicit in a CWM site, and the work plan describes waste segregation plans to reduce transport of potentially hazardous waste.

BMP G-5: When possible avoid/minimize use of hazardous/toxic materials that may require special handling or disposal

Examples:

- Cleaning solutions
- Pesticides
- Disposable batteries (use rechargeable batteries)
- MMRP projects: minimize Chemical Agent Contaminated Media (CACM) at RCWM sites.

Date: 1/12/12

☒ Applicable

☒ Evaluated

☒ Practical

Implemented?
("N/A" if "Practical" not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☒ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Bleach planned for decon is not particularly toxic. Use of donor explosives for potential BIP of MEC (if found) will be minimized to the extent possible.

BMP G-6: Recycle or re-use materials rather than disposing of them

Examples:

- Cardboard
- Plastics
- Concrete
- Asphalt
- Steel and other metals
- Recovered oil/product
- Mulch/compost
- MMRP projects - recycle recovered Material Documented as Safe (MDAS) after inspection and certification that the remnants are free of explosive hazards

Date: 1/12/12

☒ Applicable

☒ Evaluated

☒ Practical

Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☒ Partially ☐ Not Yet ☐ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☒ Economic ☒ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☐ Hazardous air pollutants ☒ Energy ☒ Waste
☒ Criteria pollutants ☒ Materials ☒ Safety/Community
☒ GHG emissions (CO2e) ☐ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Metal fragments that have been inspected and classified as explosive and chemical free will be sent to a recycling facility when feasible. With respect to water bottles, there was discussion during the Step 5 call that there were some potential limitations regarding site access that may limit the practicality of recycling plastic water bottles and other consumption waste. The GSR team recommends the Project Team establish if recycling such material is practical.

BMP Category H: Land Use, Ecosystems, and Cultural Resources

BMP H-1: Minimize erosion and soil transport to surface water bodies Examples: - Quickly restore any vegetated areas disrupted by equipment or vehicles - Institute appropriate erosion controls during excavation such as silt fencing	**Date:** 1/12/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☒ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Erosion control is addressed in the work plan.*	

BMP H-2: Minimize disturbances to land Examples: - Establish well-defined traffic patterns for onsite activities to minimize disturbed areas - Consider non-intrusive investigation techniques (e.g., geophysical methods) to identify items like USTs and buried drums	**Date:** 1/12/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☒ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☒ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Airborne geophysics for BG-1 and BG-2 minimizes disturbance to land (and is also expected to reduce cost).* *Using well-defined traffic patterns (also minimizes potential to encounter UXO).*	

BMP Category H: Land Use, Ecosystems, and Cultural Resources

BMP H-3: Preserve/restore ecosystems to the extent possible Examples: - Limit the removal of trees and vegetation - Attempt to transplant disturbed shrubs and small trees to other locations - Use native species for re-vegetation - Retrieve dead trees during excavation and later reposition them as habitat snags - Select and place suitably sized and typed stones into water beds and banks - Undercut surface water banks in ways that mirror natural conditions - Cut back rather than remove trees, bushes, vegetation	**Date:** 1/12/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☒ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Very little clearing is anticipated to be needed for this work, though there will be some trimming. The forest service will specify native species for any re-vegetation.*	

BMP H-4: Minimize drawdown of the water table in sensitive areas such as wetlands or areas subject to subsidence	**Date:** 1/12/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☒ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP is not applicable for this project, since no GW extraction will likely take place.*	

BMP H-5: Construct wells and other remedial process infrastructure (piping, buildings, etc.) to minimize restrictions to anticipated future use of the site	**Date:** 1/12/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☒ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP is not applicable for this project.*	

BMP H-6: Preserve/restore cultural resources to the extent possible Examples: - Protected lands such as wildlife refuges, national parks, and wilderness areas - Culturally sensitive sites such as cemeteries, native burials, and archaeological finds - Buildings or land parcels with historical significance	**Date:** 1/12/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Although it is not expected that any paleo sites will be disturbed, if any are found digging will stop and the park service will be notified.*	

BMP Category H: Land Use, Ecosystems, and Cultural Resources

<table>
<tr><td colspan="3">BMP H-7: Document sensitive ecological and cultural resources prior to initiating actions that might diminish or destroy those resources
Examples:
- Photodocument conditions prior to clearing brush
- MMRP projects: photodocument conditions prior to BIP</td><td>Date: 1/12/12
☒ Applicable
☒ Evaluated
☒ Practical</td></tr>
<tr><td>Implemented?
("N/A" if "Practical" not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☐ Economic ☐ Social</td><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="2">Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☒ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

Work has previously been performed to determine that there are no wetlands and no endangered species in the MRSs,and paleo sites have previously been mapped.</td></tr>
</table>

BMP Category I: Safety and Community

BMP I-1: Minimize and mitigate noise, light and odor disturbance during all phases of the remedial process, to the extent practicable	**Date:** 1/12/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☒ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *BIP (if needed) will be done at the end of the day with notification procedures as described in the work plan.*	

BMP I-2: Minimize dust during construction activities by spraying water or techniques such as laying biodegradable mats, tarps, or materials (already in EM385-1-1)	**Date:** 1/12/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☒ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☒ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☒ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☒ BMP otherwise required? If checked, required by: *EM385-1-1*
Notes (including discussion of possible value of implementing the BMP): *Dust will be monitored, and if needed, activities will stop and/or water for suppression will be brought in. These costs for potentially bringing in water cannot be quantified at this point since the extent of the need is unknown.*	

BMP Category I: Safety and Community

BMP I-3: Select transportation routes for trucks and heavy equipment that minimize impacts to residential areas to maximize safety and minimize noise and other aesthetic impacts	**Date:** 1/12/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☒ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Residences are sparse, and this project should not cause disturbances o residential areas due to heavy equipment transport.*	

BMP I-4: Minimize drawdown of the water table in areas that could impact production rates at supply wells and/or irrigation wells	**Date:** 1/12/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☒ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP is not applicable for this project.*	

BMP Category I: Safety and Community

BMP I-5: Minimize amount of time that heavy machinery is needed to enhance safety	**Date:** 1/12/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☒ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This is implicit for cost and schedule as well as safety. Also, for CWM projects there are specific daily and weekly limits on hours worked, which enhances safety.*	

BMP I-6: Minimize handling of dangerous chemicals by selecting alternate chemicals and/or engineering to minimize contact with chemicals (for MMRP projects, there is enhanced risk related to explosion potential and exposure to chemical agents (CA) and agent breakdown products (ABP) associated with RCWM responses)	**Date:** 1/12/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☒ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Handling of explosives will be minimized. This is also inherent in MMRP projects.*	

BMP I-7: Contribute to local economy when possible Examples: - Consider leasing local office space - Purchase or lease equipment from local vendors - Hire workers from local community	**Date:** 1/12/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☒ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Will buy supplies and services from local vendors whenever possible (e.g., ambulance, security, water delivery, diesel delivery, equipment rental, gravel from local quarry). The General Contractor for operating heavy machinery is local. Staying in local hotels and eating at restaurants during field work will provide benefit to local economy. However, due to the specialized nature of MMRP work, the labor for the intrusive work and geophysics work must be brought to the site.

BMP Category J: Other Site-Specific BMPs

BMP J-1:			**Date:**
			☐ Applicable ☐ Evaluated ☐ Practical
Implemented? (“N/A” if “Practical” not checked) ☐ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A		
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000		
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use		☐ BMP otherwise required? If checked, required by:	
Notes (including discussion of possible value of implementing the BMP):			

BMP J-2:			**Date:**
			☐ Applicable ☐ Evaluated ☐ Practical
Implemented? (“N/A” if “Practical” not checked) ☐ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A		
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000		
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use		☐ BMP otherwise required? If checked, required by:	
Notes (including discussion of possible value of implementing the BMP):			

Appendix B

Assumptions for SiteWise Input and Other Calculations, Former BHAD

Planned RI Activities (Baseline)

Appendix B
Assumptions for SiteWise Input and Other Calculations
Former Black Hills Army Depot Pilot GSR Evaluation:

Planned RI Field Activities (Baseline)

SiteWise "RA_Baseline_NoFR_1" Directory

This GSR evaluation pertains to Remedial Investigation/Feasibility Study (RI/FS) activities associated with three Munitions Response Sites (MRSs) at the former BHAD:

- Chemical Warfare Burning Pit Area (CWBPA)
- Burial Ground #1 (BG-1)
- Burial Ground #1 (BG-2)

This is a project conducted under the Military Munitions Response Program (MMRP) program. Some of the RI field activities (geophysics) were completed in 2011, and the remainder of the RI field investigation (intrusive investigation and MC sampling) will be conducted starting in spring 2012.

The notes pertaining to SiteWise input are organized by the following tabs of the SiteWise input sheet:

- Personnel Transportation – Uses "Remedial Investigation" tab of the SiteWise input sheet
- Equipment and Materials Transportation and Use – Uses "Remedial Action Construction" tab of SiteWise input sheet
- Electricity Use – Uses "Remedial Action Operations" tab of SiteWise input sheet
- Disposal – Uses "Longterm Monitoring" tab of SiteWise input sheet

For each section of SiteWise, all the sections are listed, with pertinent information added only for those sections of the input sheet where data were added.

Other calculations done outside of SiteWise are then presented. These include the following:

- % of total energy from renewable resources
- Hazardous air pollutants
- Refined material use
- Unrefined material use
- Tons of non-hazardous waste
- Tons of hazardous waste
- Risks to on-site works and from transportation
- Heavy truck trips through residential areas

Additional tables are attached which show how SiteWise outputs were split into "direct" and "indirect" energy use and greenhouse gas emissions. For definitions of direct and indirect energy use and emissions, please refer to section 2.2.2 of the evaluation report.

Baseline – Overview

Capital costs for this project were broken out by the Project Team into the following categories:

- USACE: $1,725,000
- Other Government Agencies: $2,500,000
- Task Order Amount: $3,500,000

The sum of these costs, $7,725,000, represents the total capital cost for this RI. Since the RI represents a one-time action, no subsequent annual costs or cost discounting are included in this report.

Baseline – Personnel Transportation

Scope of Work

Transportation of Personnel

Meetings (~5) usually in Pierre, SD where state regulator is located. Based on TPP meeting 11/22/10 assume the following people traveling for each meeting

- State regulator – 1 person, no miles
- EPA regulator – from Denver to Pierre (1 person, 400 miles by air each way)
- Parsons from Denver (1 person, 400 miles by air each way)
- Parsons from Huntsville (1 person, 1200 miles by air each way)
- USACE person from Omaha (1 person, drive 400 miles each way)
- USACE from Huntsville (4 people, 1200 miles by air each way)

Local Travel:

- Geophysics: 5 people for 10 days in 2 vehicles, 38 miles each way hotel to trailer
- Intrusive and MC:
    - 40 people for 4 months (17 wks = 85 days) in 10 vehicles (vans), 38 miles each way hotel to trailer
    - ambulance (van) for 4 months (17 wks = 85 days), assume 400 miles total
    - 4 ATV's for 4 months (17 wks = 85 days), assume 20 miles per day

Travel to local area for field staff:

- For geophysics assume there is 1 trip per person (10 round trips total) with 2 of the round trips by car (assume 1-person per car, 500 miles each way average) and 8 of the round trips by air (assume 1500 miles each way average)
- For intrusive investigation, assume there is 2 round trips per person (80 round trips total) with 16 of the round trips by car (assume 1-person per car, 500 miles each way average) and 64 of the round trips by air (assume 1500 miles each way average)

Baseline – Personnel Transportation

<u>Input into "Remedial Investigation" tab of SiteWise Input Sheet.xls</u>

- Baseline Information
  - Remedial Investigation Cost
    - Total remedial investigation cost ($) – leave blank

- Material Production
  - Well Materials
  - Treatment Chemicals & Materials
  - Treatment Media
  - Construction Materials
  - Well Decommissioning
  - Bulk Material Quantities

- Transportation
  - Personnel Transportation – Road
    - Trip 1 – USACE from Omaha to Pierre for 5 meetings. Assume car, gasoline. 800 miles round trip, 5 trips taken, 1 traveler per vehicle.
    - Trip 2 – Geophysics personnel, local travel from hotel to trailer. Assume car, gasoline. 76 miles round trip, 10 trips taken*2 vehicles, 2.5 travelers per vehicle.
    - Trip 3 – Intrusive and MC personnel, local travel from hotel to trailer. SUVs used in place of vans. 76 miles round trip, 850 total trips (85 trips taken*10 vehicles), 4 travelers per vehicle.
    - Trip 4 – Ambulance for intrusive and MC investigation. SUV used in place of ambulance. Assume 400 miles total, use 1 trip to represent 17 week investigation, 1 traveler (assuming ambulance will not need to be used for emergency transport, only accounting for driving ambulance back and forth to site).
    - Trip 5 – ATVs for intrusive and MC investigation. Cars used in place of ATVs. Assume 20 miles per day, 85 trips (i.e. 1 trip per day for 17 weeks)*4 ATVs, assume 1 traveler per vehicle. For vehicular fuel economy, assume 20 miles per gallon.
    - Trip 6 – Travel to local area for field staff (geophysics and intrusive combined). Assume cars, gasoline. Assume 1000 miles round trip per car; 1 trip each * 2 people for geophysics plus 2 trips each * 8 people for intrusive investigation (18 round trips total); 1 traveler per car
  - Personnel Transportation – Air
    - Trip 1 – EPA Regulator and Parsons from Denver to Pierre for 5 meetings. 800 miles round trip, 2 travelers, 5 flights taken per traveler.
    - Trip 2 – Parsons and USACE from Huntsville to Pierre for 5 meetings. 2400 miles round trip, 5 travelers, 5 flights taken per traveler.
    - Trip 3 – Travel to local area for geophysics field staff. Assume 3000 miles round trip, 8 travelers, and 1 flight taken per traveler.
    - Trip 4 – Travel to local area for intrusive investigation field staff. Assume 3000 miles round trip, 32 travelers, and 2 flights taken per traveler.
  - Personnel Transportation – Rail
  - Equipment Transportation – Road

  - Equipment Transportation – Air
  - Equipment Transportation – Rail
  - Equipment Transportation – Water

- Equipment Use
  - Earthwork
  - Drilling
  - Trenching
  - Pump Operation
  - Diesel and Gasoline Pumps
  - Blower, Compressor, Mixer, and Other Equipment
  - Generators
  - Agricultural Equipment
  - Capping Equipment
  - Mixing Equipment
  - Internal Combustion Engines
  - Other Fueled Equipment
  - Operator Labor
  - Laboratory Analysis
  - Other Known Onsite Activities

- Residual Handling
  - Residue Disposal/Recycling
  - Landfill Operations
  - Thermal/Catalytic Oxidizers

- Resource Consumption
  - Water Consumption
  - Onsite Land and Water Resource Consumption

Once SiteWise input is complete, go to "SiteWise_Input Sheet" for overall project and enter information (including Alternative File Name "Baseline"). Then go to "Generate Alternative" tab and click button labeled "Click to generate alternative using previously entered alternative name". Copies of the input and output summary sheets for this alternative are now located in the directory titled "RA_Baseline _NoFR_1". To store the "Remedial Investigation.xls" calculation sheet showing detailed calculations, open it in the overall SiteWise project directory when the appropriate input sheet is open, then do a "save as" to put it in the directory for this alternative using a name that indicates "will not update". Then open that file and do "data->edit links" and break the links. If the input sheet for this alternative ever changes, then this calculation sheet needs to be re-saved.

To edit input parameters for this alternative, you must go back to the ORIGINAL SiteWise input sheet and import this alternative using the "Do you want to reload a previously saved remedial alternative in the SiteWise input sheet?" field on the "Site Info" tab. After making necessary changes to the input sheet, re-export the alternative by going to the "Generate Alternative" tab and clicking the button labeled "Click to replace an existing alternative with the same name". Update saved calculation sheets as described above.

Baseline – Equipment and Materials Transportation and Use

Scope of Work

Transportation of Equipment and Materials

Geophysics:

- Helicopter for geophysics out of Toronto, Canada – 1200 gallons diesel indicated during Step 5 call (occurring over a period of approximately 10 days)
    - Note: Assume for apportioning off-site and on-site, assume helicopter gets 8 mpg and distance from Toronto to site is ~1200 miles, thus 150 gallons used each way = 300 gallons total for off-site use, the balance of 900 gallons assumed to be used on-site.
- Truck for porta-john cleaning= 100 miles (RT) * 2 (assume once per week for 2 wks)

Intrusive:

- 1 excavator, 1 front-end loader, and one backhoe for 4 months (17 wks = 85 days), drop off = 50 miles and pickup = 50 miles for each (must account for empty roundtrip)

- Truck for Diesel/water/explosives/misc deliveries = 100 miles (RT) * 34 (assume twice per week for 17 wks), account for lighter load on return

- Truck for porta-john cleaning = 100 miles (RT) * 34 (assume twice per week for 17 wks)

- Truck for clean fill (gravel) - assume 100 dump truck loads (1500 yds / 15 yds per load) * 50 miles each way, each load = 22.5 tons (15 yds * 1.5 ton/yd), must account for lighter load on return

- Truck for geotextile fabric – assume 1 flat-bed truck, 50 miles each way

Operation of Equipment

1 excavator for 4 months (17 wks = 85 days) assume active for 6 hrs/day
1 front-end loader for 4 months (17 wks = 85 days) assume active for 6 hrs/day
one backhoe for 4 months (17 wks = 85 days) assume active for 6 hrs/day

Materials

- Water for decon – assume 100 gallons per day during intrusive investigation for 85 days (17 wks * 5 days).
- Clean fill (gravel) for roads – assume 1500 cubic yards
- Geotextile fabric for excavations – 20 ft width * 1000 ft/roll * 2 rolls
- Plastic sheeting – not quantified
- Sandbags – not quantified
- Explosives for BIP (discussed in Chapter 5 of work plan)
    - Assume 31 lbs (62 lbs to be delivered to site per table 5-1 of work plan, assume half will be used (31 lbs) and half will be donated (per section 5.11 of the work plan, one option for unused explosives is to donate to local law enforcement, which is likely the most sustainable option)

Baseline – Equipment and Materials Transportation and Use

Transportation for Monitoring

There are two labs mentioned in the SAP (Appendix E of the work plan), each lab analyzes for specific constituents as detailed on table 5-1 in Appendix E.1 of the SAP:

- U.S. Army ECBC, Aberdeen Proving Grounds, MD
  - Assume 2000 miles via air each way (empty coolers one way and full coolers the other way). Assume 40 coolers shipped total each weighing 10 lbs empty and 50 lbs full.

- APPL, Fresno, CA
  - Assume 1500 miles via air each way (empty coolers one way and full coolers the other way). Assume 40 coolers shipped total, each weighing 10 lbs empty and 50 lbs full.

Baseline – Equipment and Materials Transportation and Use

Input into "Remedial Action Construction" tab of SiteWise Input Sheet.xls

- Baseline Information
  - Remedial Action Construction Cost
    - Total remedial action construction cost ($) – leave blank

- Material Production
  - Well Materials
  - Treatment Chemicals & Materials
    - Treatment 1 – Phosphate fertilizer used to represent explosives for BIP (assumed to have similar footprint). For SiteWise input, use 1 injection point with one injection per point. Select phosphate fertilizer, 31 pounds of material.
  - Treatment Media
  - Construction Materials
    - Material 1 – Geotextile fabric for excavations. Use HDPE liner to represent geotextile fabric. Area of material is 40,000 ft^2 (20ft wide sheet * 1000ft/roll * 2 rolls). Depth of material is 0.003333333 ft (40 mils / 1000 mils per inch / 12 inches per foot).
    - Material 2 – Clean fill (gravel) for roads. Select gravel for material type. Assume 40500 cubic feet (1500 cubic yards), or 40500 ft^2 by 1 ft thick for purposes of SiteWise entry.
  - Well Decommissioning
  - Bulk Material Quantities

- Transportation
  - Personnel Transportation – Road
    - Trip 1 – Truck for geophysics porta-john cleaning. Select heavy duty vehicle, diesel. 100 miles round trip, 2 trips taken (assuming once per week for 2 weeks), 1 traveler (driver).
    - Trip 2 – Truck for intrusive/MC porta-john cleaning. Select heavy duty vehicle, diesel. 100 miles round trip, 34 trips taken (assuming twice per week for 17 weeks), 1 traveler (driver).
    - Trip 3 – Truck for intrusive/MC investigation for diesel/water/explosives/misc deliveries. Select heavy duty vehicle, diesel. 100 miles round trip, 34 trips taken (assuming twice per week for 17 weeks), 1 traveler (driver).
  - Personnel Transportation – Air
  - Personnel Transportation – Rail
  - Equipment Transportation – Road
    - Trip 1 – Transport of 1 excavator, 1 front-end loader, and 1 backhoe to and from site. Assume diesel fuel. 100 miles round trip carrying equipment (empty return and pickup trips included separately below), assume an average of approximately 10 tons per piece of equipment, for 30 tons total.
    - Trip 2 – Transport for clean fill (gravel). Assume diesel fuel. 50 miles one way (empty return trips included separately below) * 100 dump truck loads, 22.5 tons per dump truck load (15 yds in one load * 1.5 tons/yd).
    - Trip 3 – Transport for geotextile fabric. Assume diesel fuel. 50 miles one way (empty return trip included separately below). Weight of geotextile fabric

(obtained from SiteWise output file for Remedial Action Construction Tab) approximately 4 tons (3643.4 kg * 2.2 lbs per kg / 2000 lbs per ton).

- Trip 4 – Empty return trips. Assume diesel fuel. 100 miles for trip 1 + 50 miles * 100 trips for trip 2 + 50 miles for trip 3 = 5150 miles. Enter 0 for equipment weight.

- Equipment Transportation – Air
  - Trip 1 – Samples shipped to lab (U.S. Army ECBC, Aberdeen Proving Grounds, MD). Assume 2000 miles from site to lab, 40 coolers * 50 lbs each when full = 2000 lbs total (= 1 ton).
  - Trip 2 – Samples shipped to lab (ALLP, Fresno, CA). Assume 1500 miles from site to lab, 40 coolers*50 lbs each when full = 2000 lbs total (= 1 ton).
  - Trip 3 – Empty coolers shipped from lab (U.S. Army ECBC, Aberdeen Proving Grounds, MD). Assume 2000 miles from lab to site, 40 coolers * 10 lbs each when empty = 400 lbs total (= 0.2 tons).
  - Trip 4 – Empty coolers shipped from lab (ALLP, Fresno, CA). Assume 1500 miles from lab to site, 40 coolers*10 lbs each when full = 400 lbs total (= 0.2 ton).
- Equipment Transportation – Rail
- Equipment Transportation – Water

- Equipment Use
  - Earthwork
  - Drilling
  - Trenching

    Trenching used here to represent excavator and loader operation. Excavators and loaders in SiteWise are typically entered under earthwork, but SiteWise only allows input in cubic yards of material to be moved. It then selects an excavator or loader in the lookup table based on the amount of material to be moved (larger excavators or loaders for more material). However, since for this project we know the approximate hours of operation for the equipment, and since equipment will be used for trench pits rather than a single, large excavation, using a trencher as a surrogate for this equipment makes the most sense.

    To choose the appropriate horsepower range for the trencher, select the size excavator or loader that will be used for the project in SiteWise lookup table 3b. For the selected equipment, look at the fuel consumption rate, then find a trencher SiteWise table 6k with a similar fuel consumption rate and use the horsepower range listed for that trencher.

    - Trencher 1 – Surrogate for excavator used for trenching. Assume diesel. For this project, assume a fairly small excavator – “Excavator, Hydraulic, 1.5 CY” in lookup table 3b, which has a fuel consumption rate of 7.9 gal/hr. This consumption rate matches most closely to the consumption rate of 7.8 gal/hr for the 175 to 300 HP trencher in lookup table 6k. Therefore, select 175 to 300 HP from the dropdown menu for trencher input. Assume 6 hrs/day of excavator use for 17 weeks (85 days) for a total of 510 hours of operation.
    - Trencher 2 – Surrogate for front-end loader used for trenching. Assume diesel. For this project, assume a fairly small loader – “Loader, 80 HP, 1.5 CY” in lookup

table 3b, which has a fuel consumption rate of 1.8 gal/hr. This consumption rate matches most closely to the consumption rate of 1.6 gal/hr for the 40 to 50 HP trencher in lookup table 6k. Therefore, select 40 to 50 HP from the dropdown menu for trencher input. Assume 6 hrs/day of loader use for 17 weeks (85 days) for a total of 510 hours of operation.

    - Trencher 3 – Surrogate for backhoe used for trenching. Assume diesel. For this project, assume a fairly small backhoe – "Loader, 80 HP, 1.5 CY" in lookup table 3b, which has a fuel consumption rate of 1.8 gal/hr. This consumption rate matches most closely to the consumption rate of 1.6 gal/hr for the 40 to 50 HP trencher in lookup table 6k. Therefore, select 40 to 50 HP from the dropdown menu for trencher input. Assume 6 hrs/day of excavator use for 17 weeks (85 days) for a total of 510 hours of operation.
  - Pump Operation
  - Diesel and Gasoline Pumps
  - Blower, Compressor, Mixer, and Other Equipment
  - Generators
  - Agricultural Equipment
  - Capping Equipment
  - Mixing Equipment
  - Internal Combustion Engines
  - Other Fueled Equipment
    - Fuel 1 – Fuel for Helicopter for geophysics out of Toronto, Canada. Select jet fuel, 1200 gallons
  - Operator Labor
  - Laboratory Analysis
  - Other Known Onsite Activities
    - Water consumption – Water for decon during intrusive investigation. Assume 100 gal per day * 85 days = 8500 gallons total.

- Residual Handling
  - Residue Disposal/Recycling
  - Landfill Operations
  - Thermal/Catalytic Oxidizers

- Resource Consumption
  - Water Consumption
  - Onsite Land and Water Resource Consumption

Once SiteWise input is complete, go to "SiteWise_Input Sheet" for overall project and enter information (including Alternative File Name "Baseline"). Then go to "Generate Alternative" tab and click button labeled "Click to generate alternative using previously entered alternative name". Copies of the input and output summary sheets for this alternative are now located in the directory titled "RA_Baseline _NoFR_1". To store the "Remedial Action Construction.xls" calculation sheet showing detailed calculations, open it in the overall SiteWise project directory when the appropriate input sheet is open, then do a "save as" to put it in the directory for this alternative using a name that indicates "will not update". Then open that file and do "data->edit links" and break the links. If the input sheet for this alternative ever changes, then this calculation sheet needs to be re-saved.

Baseline – Equipment and Materials Transportation and Use

To edit input parameters for this alternative, you must go back to the ORIGINAL SiteWise input sheet and import this alternative using the "Do you want to reload a previously saved remedial alternative in the SiteWise input sheet?" field on the "Site Info" tab. After making necessary changes to the input sheet, re-export the alternative by going to the "Generate Alternative" tab and clicking the button labeled "Click to replace an existing alternative with the same name". Update saved calculation sheets as described above.

Baseline – Electricity Use

<u>Scope of Work</u>

<u>Electricity</u>

Field office – hooked up to electric (empty in winter)

- Lights plus computers and other gadgets – 0.5 kW * 12 hrs/d * 180 days total
- AC – assume 2 kW * 12 hrs/d * 60 days (need AC)

IHF

- Need lighting dusk to dawn at IHF, but only after material is placed in IHF
  - Will initially use generator until electricity is connected, assume fuel to run 6 kW generator 12 hrs/day for 2 weeks
  - Then will use electricity, assume 2 months to power spotlights continuously , 4 bulbs * 1 kW/bulb * 12 hrs/d * 60 days
- no cooling needed since using existing igloos

Baseline – Electricity Use

<u>Input into “Remedial Action Operations” tab of SiteWise Input Sheet.xls</u>

- Baseline Information
    - Remedial Action Operations Cost and Duration
        - Total remedial action operations cost ($) – leave blank
        - Duration of remedial action operations (unit time) – 1 yr for this GSR evaluation

- Material Production
    - Well Materials
    - Treatment Chemicals & Materials
    - Treatment Media
    - Construction Materials
    - Well Decommissioning
    - Bulk Material Quantities

- Transportation
    - Personnel Transportation – Road
    - Personnel Transportation – Air
    - Personnel Transportation – Rail
    - Equipment Transportation – Road
    - Equipment Transportation – Air
    - Equipment Transportation – Rail
    - Equipment Transportation – Water

- Equipment Use
    - Earthwork
    - Drilling
    - Trenching
    - Pump Operation
        - Pump 1 – Used to represent electrical usage at field office for lights, computers, etc. Use method 1, which allows for direct input of electrical usage in kWh. Assume 0.5 kW * 12 hours per day * 180 days = 1080 kWh.
        - Pump 2 – Used to represent electrical usage at field office for AC. Use method 1, which allows for direct input of electrical usage in kWh. Assume 2 kW * 12 hours per day * 60 days when AC is needed = 1440 kWh.
        - Pump 3 – Used to represent electrical usage for lighting dusk to dawn at IHF. Use method 1, which allows for direct input of electrical usage in kWh. Assume 1 kW per bulb * 4 bulbs * 12 hrs per day * 60 days = 2880 kWh.
    - Diesel and Gasoline Pumps
    - Blower, Compressor, Mixer, and Other Equipment
    - Generators
        - Generator 1 – Generator for lighting at IHF. Assume gasoline, 6 kW generator (which would equate to a generator in the 6 to 11 HP range) 12 hrs/day for 2 weeks (168 hours).
    - Agricultural Equipment
    - Capping Equipment
    - Mixing Equipment
    - Internal Combustion Engines

  - Other Fueled Equipment
  - Operator Labor
  - Laboratory Analysis
  - Other Known Onsite Activities

- Residual Handling
  - Residue Disposal/Recycling
  - Landfill Operations
  - Thermal/Catalytic Oxidizers

- Resource Consumption
  - Water Consumption
  - Onsite Land and Water Resource Consumption

Once SiteWise input is complete, go to "SiteWise_Input Sheet" for overall project and enter information (including Alternative File Name "Baseline"). Then go to "Generate Alternative" tab and click button labeled "Click to generate alternative using previously entered alternative name". Copies of the input and output summary sheets for this alternative are now located in the directory titled "RA_Baseline _NoFR_1". To store the "Remedial Action Opeartions.xls" calculation sheet showing detailed calculations, open it in the overall SiteWise project directory when the appropriate input sheet is open, then do a "save as" to put it in the directory for this alternative using a name that indicates "will not update". Then open that file and do "data->edit links" and break the links. If the input sheet for this alternative ever changes, then this calculation sheet needs to be re-saved.

To edit input parameters for this alternative, you must go back to the ORIGINAL SiteWise input sheet and import this alternative using the "Do you want to reload a previously saved remedial alternative in the SiteWise input sheet?" field on the "Site Info" tab. After making necessary changes to the input sheet, re-export the alternative by going to the "Generate Alternative" tab and clicking the button labeled "Click to replace an existing alternative with the same name". Update saved calculation sheets as described above.

Baseline – Disposal

Scope of Work

Transportation for Disposal

It is not possible to provide the quantities of waste disposal for each category of waste (i.e., chemical agent to be incinerated versus hazardous waste versus non-hazardous waste) until after the RI activities are complete.

Baseline – Disposal

<u>Input into “Longterm Monitoring” tab of SiteWise Input Sheet.xls</u>

- Baseline Information
  - Longterm Monitoring Cost and Duration
    - Total remedial action operations cost ($) – leave blank
    - Duration of Longterm Monitoring (unit time) – 1 yr for this GSR evaluation

- Material Production
  - Well Materials
  - Treatment Chemicals & Materials
  - Treatment Media
  - Construction Materials
  - Well Decommissioning
  - Bulk Material Quantities

- Transportation
  - Personnel Transportation – Road
  - Personnel Transportation – Air
  - Personnel Transportation – Rail
  - Equipment Transportation – Road
  - Equipment Transportation – Air
  - Equipment Transportation – Rail
  - Equipment Transportation – Water

- Equipment Use
  - Earthwork
  - Drilling
  - Trenching
  - Pump Operation
  - Diesel and Gasoline Pumps
  - Blower, Compressor, Mixer, and Other Equipment
  - Generators
  - Agricultural Equipment
  - Capping Equipment
  - Mixing Equipment
  - Internal Combustion Engines
  - Other Fueled Equipment
  - Operator Labor
  - Laboratory Analysis
  - Other Known Onsite Activities

- Residual Handling
  - Residue Disposal/Recycling
  - Landfill Operations
  - Thermal/Catalytic Oxidizers

- Resource Consumption

Baseline – Disposal

- Water Consumption
- Onsite Land and Water Resource Consumption

Once SiteWise input is complete, go to "SiteWise_Input Sheet" for overall project and enter information (including Alternative File Name "Baseline"). Then go to "Generate Alternative" tab and click button labeled "Click to generate alternative using previously entered alternative name". Copies of the input and output summary sheets for this alternative are now located in the directory titled "RA_Baseline _NoFR_1". To store the "Longterm Monitoring.xls" calculation sheet showing detailed calculations, open it in the overall SiteWise project directory when the appropriate input sheet is open, then do a "save as" to put it in the directory for this alternative using a name that indicates "will not update". Then open that file and do "data->edit links" and break the links. If the input sheet for this alternative ever changes, then this calculation sheet needs to be re-saved.

To edit input parameters for this alternative, you must go back to the ORIGINAL SiteWise input sheet and import this alternative using the "Do you want to reload a previously saved remedial alternative in the SiteWise input sheet?" field on the "Site Info" tab. After making necessary changes to the input sheet, re-export the alternative by going to the "Generate Alternative" tab and clicking the button labeled "Click to replace an existing alternative with the same name". Update saved calculation sheets as described above.

Other Supporting Calculations:
Current P&T Systems (Baseline)

% of Total Energy Usage from Renewable Resources

- No on-site renewable energy generation was noted, and eGRID says that for this region of the country 8.8% of the electricity is from renewable sources. SiteWise reports that 55.84 MMBtu of the energy use is from electricity. Since the total energy use is 21,515 MMBtu, percent of energy from renewable resources is 55.84/4,116 * 100 * 8.8% = 0.12%

Hazardous Air Pollutants

- None identified.

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Refined Materials Use

- 31 lbs of explosives (assume that only half of the explosives for BIP will be used on-site).
- SiteWise reports 3,643.4 kg of geotextile fabric (equal to 8,032.3 lbs).
- Have not quantified use of plastics or PPE.

Unrefined Materials Use

- SiteWise reports 1,928,972.1 kg of gravel for roads (equal to 2,126.3 tons).

Tons of Non-Hazardous Waste

- Not quantified. It is not possible to provide the quantities of waste disposal for each category of waste until after the RI activities are complete.

Tons of Hazardous Waste

- Not quantified. It is not possible to provide the quantities of waste disposal for each category of waste until after the RI activities are complete.

Risks to On-Site Workers and from Transportation

- 0.27 injuries or fatalities during planned RI activities.
    - 0.20 from transportation
    - 0.07 for on-site workers

Heavy Truck Trips through Residential Areas

- None identified.

GSR Team Calculations to Split Energy Results from SiteWise into "Direct" and "Indirect"
Planned RI Field Activities (Baseline)

phase	Reported by SiteWise: activity	Reported by SiteWise: energy used (MMBTU)	Assigned by GSR Team from SiteWise Output: Scope 1 (direct) energy used (MMBTU)	Assigned by GSR Team from SiteWise Output: Scope 2 (indirect) energy used (MMBTU)	Assigned by GSR Team from SiteWise Output: Scope 3 (indirect) energy used (MMBTU)	Total Calculated by GSR Team
Personnel Transportation – Uses "Remedial Investigation" tab	Consumables	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	1241.58	38.28	0.00	1203.29	1241.58
	Transportation-Equipment	0.00	0.00	0.00	0.00	0.00
	Equipment Use and Misc	0.00	0.00	0.00	0.00	0.00
	Residual Handling	0.00	0.00	0.00	0.00	0.00
	Sub-Total	1241.58	38.28	0.00	1203.29	1241.58
Equipment and Materials Transportation and Use – Uses "Remedial Action Construction" tab	Consumables	907.30	0.00	0.00	907.30	907.30
	Transportation-Personnel	128.50	0.00	0.00	128.50	128.50
	Transportation-Equipment	272.26	0.00	0.00	272.26	272.26
	Equipment Use and Misc	1493.90	1201.09	0.00	292.81	1493.90
	Residual Handling	0.00	0.00	0.00	0.00	0.00
	Sub-Total	2801.97	1201.09	0.00	1600.88	2801.97
Electricity Use – Uses "Remedial Action Operations" tab	Consumables	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	0.00	0.00	0.00	0.00	0.00
	Transportation-Equipment	0.00	0.00	0.00	0.00	0.00
	Equipment Use and Misc	72.67	32.07	0.00	40.61	72.67
	Residual Handling	0.00	0.00	0.00	0.00	0.00
	Sub-Total	72.67	32.07	0.00	40.61	72.67
Disposal – Uses "Longterm Monitoring" tab	Consumables	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	0.00	0.00	0.00	0.00	0.00
	Transportation-Equipment	0.00	0.00	0.00	0.00	0.00
	Equipment Use and Misc	0.00	0.00	0.00	0.00	0.00
	Residual Handling	0.00	0.00	0.00	0.00	0.00
	Sub-Total	0.00	0.00	0.00	0.00	0.00
total		4116.22	1271.44	0.00	2844.78	4116.22

Note: Electricity use reported by SiteWise Version 2.0 in units of kWh is "Direct Scope 1", meaning it is energy consumed at the location of the project. However, energy use associated with electricity reported by SiteWise in units of MMBtu is a life-cycle value which also includes a factor to account for energy used elsewhere required to generate the electricity ("Indirect Scope 2"). Here, 33% of the life-cycle value reported by SiteWise is considered to be "Scope 1" on-site energy use, and 67% is considered to be "Scope 2" energy used in electricity generation.

SiteWise Version 2.0 uses fuel energy values from U.S. Department of Energy, Argonne National Laboratory, Transportation Technology R&D Center, GREET 1.8d.1, Fuel-Cycle model, 2010. This version of the GREET model reports that for Gasoline and Diesel, approximately 19% of GHG emissions are upstream emissions (scope 3) and 81% are tailpipe emissions (scope 1). For this analysis, it is assumed that energy is used in these same proportions, and therefore the energy use reported by SiteWise is split between scope 3 and scope 1 in these ratios.

GSR Team Calculations to Split GHG Results from SiteWise into "Direct" and "Indirect"
Planned RI Field Activities (Baseline)

phase	Reported by SiteWise		Assigned by GSR Team from SiteWise Output			Total Calculated by GSR Team
			Scope 1 (direct)	Scope 2 (indirect)	Scope 3 (indirect)	
	activity	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	
Personnel Transportation – Uses “Remedial Investigation” tab	Consumables	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	95.39	3.04	0.00	92.35	95.39
	Transportation-Equipment	0.00	0.00	0.00	0.00	0.00
	Equipment Use and Misc	0.00	0.00	0.00	0.00	0.00
	Residual Handling	0.00	0.00	0.00	0.00	0.00
	Sub-Total	95.39	3.04	0.00	92.35	95.39
Equipment and Materials Transportation and Use – Uses “Remedial Action Construction” tab	Consumables	43.72	0.00	0.00	43.72	43.72
	Transportation-Personnel	9.85	0.00	0.00	9.85	9.85
	Transportation-Equipment	23.54	0.00	0.00	23.54	23.54
	Equipment Use and Misc	128.88	103.55	0.00	25.33	128.88
	Residual Handling	0.00	0.00	0.00	0.00	0.00
	Sub-Total	205.99	103.55	0.00	102.44	205.99
Electricity Use – Uses “Remedial Action Operations” tab	Consumables	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	0.00	0.00	0.00	0.00	0.00
	Transportation-Equipment	0.00	0.00	0.00	0.00	0.00
	Equipment Use and Misc	6.21	1.05	4.91	0.25	6.21
	Residual Handling	0.00	0.00	0.00	0.00	0.00
	Sub-Total	6.21	1.05	4.91	0.25	6.21
Disposal – Uses “Longterm Monitoring” tab	Consumables	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	0.00	0.00	0.00	0.00	0.00
	Transportation-Equipment	0.00	0.00	0.00	0.00	0.00
	Equipment Use and Misc	0.00	0.00	0.00	0.00	0.00
	Residual Handling	0.00	0.00	0.00	0.00	0.00
	Sub-Total	0.00	0.00	0.00	0.00	0.00
Total		307.58	107.64	4.91	195.03	307.58

Note: *CO2e reported by SiteWise Version 2.0 for electricity use is all associated with generation of the electricity (“Indirect Scope 2”).*

SiteWise Version 2.0 use fuel emission factors from U.S. Department of Energy, Argonne National Laboratory, Transportation Technology R&D Center, GREET 1.8d.1, Fuel-Cycle model, 2010. This version of the GREET model reports that for gasoline and diesel, approximately 19% of GHG emissions are upstream emissions (Scope 3) and 81% are tailpipe emissions (Scope 1). For this analysis, the GHG emissions reported by SiteWise are split between Scope 3 and Scope 1 in these ratios.

FINAL REPORT

PILOT PROJECT GSR EVALUATION: FORMER NAD - HASTINGS

Sitewide Groundwater Remediation, Operable Unit 14, Former Naval Ammunition Depot, Hastings, Nebraska

Prepared for:

U.S. Army Corps of Engineers
Environmental and Munitions Center of Expertise
1616 Capitol Ave, Suite 9200
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Contract No. W912DQ-08-D-0019
Delivery Order No. ZW02

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8 March 2012

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PREFACE

The US Army Engineering and Support Center, Huntsville (USAESCH), Environmental and Munitions Center of Expertise (EM CX) has contracted Tetra Tech EC, Inc. (Tetra Tech) under Contract W912DQ-08-D-0019, Delivery Order No. ZW02, to conduct and document a Study that follows the process of considering, incorporating, documenting, and evaluating the benefits of green and sustainable remediation (GSR) practices. The objective of this Task Order is to: (1) Follow the consideration and incorporation of GSR practices into Army environmental remediation projects; (2) Ascertain the effectiveness of the GSR practices that are considered and incorporated; and (3) Provide procedures by which GSR practices that are shown to be effective can be identified, considered, implemented and documented by project teams working on Army sites. The information obtained from this Study will be used to provide recommendations to the Office of the Assistant Chief of Staff for Installation Management (OACSIM) for development of Army-wide GSR guidance and policy. This document has been prepared in accordance with the Task Order Statement of Work (SOW) entitled "*Evaluation of Consideration and Incorporation of Green and Sustainable Remediation (GSR) Practices in Army Environmental Remediation*" (26 July 2010).

The Project Delivery Team (PDT) consists of representatives and subject matter experts (SMEs) from the following organizations:

- EM CX;
- OACSIM;
- National Guard Bureau (NGB);
- Army Environmental Command (AEC);
- Tetra Tech;
- Office of the Deputy Assistant Secretary of the Army-Environmental Safety and Occupational Health (ODASA (ESOH));
- Headquarters US Army Corps of Engineers (HQ USACE) Formerly Used Defense Sites (FUDS) program;
- HQ USACE Environmental Community of Practice (ECoP) Military Munitions Support Services (M2S2);
- Huntsville Center Environmental Program; and
- Army Environmental Policy Institute (AEPI)

Specific representatives of those organizations are listed on the table at the end of this preface. This report pertains to one of the pilot projects conducted as part of the Study. Tetra Tech personnel who provided the most significant contributions to this report are as follows:

- Preparation
    - Doug Sutton (IRP GSR Technical Lead)
    - Sarah Farron

- Review
    - Rob Greenwald (Project Manager)

Sincere thanks are extended to Project Team associated with this pilot project, for their willingness to participate in this Study and for their efforts that were associated with their participation.

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Professional in Charge:

Douglas J Sutton

Doug Sutton, PhD, PE, LEED

3/8/12

Date

ACRONYMS AND ABBREVIATIONS

ACSIM	Assistant Chief of Staff for Installation Management
AEC	Army Environmental Command
AEPI	Army Environmental Policy Institute
bgs	Below ground surface
BMPs	Best Management Practices
CO_2	Carbon dioxide
CO2e	Equivalent Global Warming Potential of Carbon Dioxide
CSM	Conceptual Site Model
DoD	Department of Defense
ECoP	Environmental Community of Practice
EM CX	Environmental and Munitions Center of Expertise
ESOH	Environment, Safety, and Occupational Health
FUDS	Formerly Used Defense Sites
GAC	Granular Activated Carbon
GHG	Greenhouse gas
gpm	Gallons per minute
GSR	Green and Sustainable Remediation
GWP	Global Warming Potential
HAP	Hazardous Air Pollutant
HDPE	High-density polyethylene
HP	Horsepower
HQ USACE	Headquarters US Army Corps of Engineers
HRS	Hours
IRP	Installation Restoration Program
Kg	Kilograms
kWh	Kilowatt-hours
lbs	Pounds
L	Liters
M2S2	Military Munitions Support Services
MBtu	Metric British Thermal Units
Mg	Milligrams
MJ	Mega Joules
MMBtu	Million Metric British Thermal Units
MMRP	Military Munitions Response Program
MNA	Monitored Natural Attenuation
MWh	Megawatt hours
NAD	Naval Ammunition Depot
NGB	National Guard Bureau
NOx	Nitrogen Oxides
NPV	Net present value
O&M	Operations and Maintenance
OACSIM	Office of the Assistant Chief of Staff for Installation Management
ODASA	Office of the Deputy Assistant Secretary of the Army
OU	Operable Unit
P&T	Pump and Treat
PDT	Project Delivery Team
PM	Particulate Matter
RDX	Hexahydro-1,3,5-trinitro-1,3,5-triazine

ROD	Record of Decision
SAIC	Science Applications International Corporation
SiteWise	Battelle SiteWise™ Sustainable Environmental Remediation Tool
SMEs	Subject matter experts
SOW	Statement of Work
SOx	Sulfur Oxides
TCE	Trichloroethene
TNT	2,4,6-trinitrotoluene
US	United States
USACE	United States Army Corps of Engineers
USAESCH	US Army Engineering and Support Center, Huntsville
VFD	Variable Frequency Drive
VOC	Volatile organic compound

1.0 INTRODUCTION

1.1 ACSIM GSR STUDY AND PURPOSE OF THIS GSR EVALUATION

The US Army Engineering and Support Center, Huntsville (USAESCH), Environmental and Munitions Center of Expertise (EM CX) has contracted Tetra Tech EC, Inc. (Tetra Tech) under Contract W912DQ-08-D-0019, Delivery Order No. ZW02, to conduct and document a Study that follows the process of considering, incorporating, documenting, and evaluating the benefits of green and sustainable remediation (GSR) practices (hereafter referred to as "the Study"). The objective of the Study is to: (1) Follow the consideration and incorporation of GSR practices into Army environmental remediation projects; (2) To ascertain the effectiveness of the GSR practices that are considered and incorporated; and (3) Provide procedures by which GSR practices that are shown to be effective can be identified, considered, implemented and documented by project teams working on Army sites. The information obtained from this Study will be used to provide recommendations to the Office of the Assistant Chief of Staff for Installation Management (OACSIM) for development of Army-wide GSR guidance and policy.

One component of the Study described above is to perform a GSR evaluation at 12 Army "Pilot Projects" that are in various phases of the remedial process. This report presents the Pilot Project GSR Evaluation for the Sitewide Groundwater Remediation, Operable Unit 14, Former Naval Ammunition Depot, Hastings, Nebraska (hereafter referred to as "Former NAD – Hastings"). This GSR evaluation was initially conducted in January and February 2011 (draft GSR report dated 5 February 2011), using a draft version of a GSR approach developed during the Study and documented in the following report: *Process for Consideration and Incorporation of Green and Sustainable Remediation (GSR) Practices in Army Environmental Remediation (draft dated 19 January 2011, later finalized on 26 May 2011).* Some changes to the Draft GSR report for this Pilot Project have been to address changes to the GSR process used for the Study that occurred after the Draft GSR Report was submitted in February 2011 (to be consistent with reports for subsequent Pilot Projects). However, since this GSR report is being finalized more than a year after the Draft GSR report was submitted, the dates presented on specific items in this report (such as dates provided on forms in Appendix A, cost sheets in Appendices B and C, and recommendations in Section 3) have been preserved to reflect the original dates when the technical portion of the GSR evaluation was actually performed.

One purpose for the pilot projects is to provide testing of the GSR approach developed during the Study, and that approach will be refined and finalized later in the Study based on lessons learned from this and other pilot projects. In addition, it is anticipated that this GSR evaluation will provide the Project Team for Former NAD – Hastings with information and/or recommendations that will be beneficial for their project.

This report refers to "teams" that are defined as follows:

- Study Team: This is the team conducting a Study being led by USACE EM CX that follows the process of considering, incorporating, documenting, and evaluating the benefits of green and sustainable remediation practices for Army projects.

- Project Team: Refers to those associated with implementation of the remedial process for the pilot projects.

- GSR Team: Refers to the personnel that perform a specific GSR evaluation. For this Study, the GSR Team consists of personnel from Tetra Tech, which is a contractor to USACE for the Study.

In this Study, an "EM CX liaison" for each of the pilot projects serves as a bridge between the USACE Study project manager (Carol Dona), the Study contractor performing the GSR evaluation (Tetra Tech), and the Project Team manager for the specific pilot.   For this pilot project the EM CX Liaison is Dave Becker.

1.2 TECHNICAL OVERVIEW: FORMER NAD - HASTINGS

1.2.1 Overview of Site Location, Setting, and Contamination

Former NAD – Hastings was built in the 1940s following government purchase of 48,753 acres (76.2 square miles) of land in south central Nebraska. The former NAD is located immediately east of Hastings, Nebraska in eastern Adams County and western Clay County (Figure 1-1, which is a duplicate of Figure 1-1 from the 30 Percent Design). Hastings is located 25 miles south of Grand Island, Nebraska and 105 miles west of Lincoln, Nebraska. The city of Hastings has a population of approximately 24,000 and is an important agribusiness center to the surrounding region.

The former NAD was subdivided into five Operable Units (OUs). Four of the OUs consist of shallow soil or vadose zone soil located near various former production and waste disposal facilities. OU14, the subject of this GSR evaluation, encompasses site-wide groundwater at the former NAD. Groundwater is used for drinking water and industrial/agricultural purposes. The geology and hydrogeology of the former NAD and surrounding area have been studied extensively. A brief description of the geology and hydrogeology, based on the August 2010 ROD, is provided below.

- Depth to groundwater is approximately 95 to 120 feet below ground surface (bgs) across most of the former NAD.

- Groundwater underlying the former NAD can be divided into the following general hydrogeologic units (from top to bottom):

    - Unconfined aquifer
    - Upper-confining layer
    - Semi-confined aquifer
    - Lower-confining unit

- Groundwater is the primary source of drinking water in the Hastings area.

- The direction of groundwater flow through the region is historically to the east and southeast, and groundwater flow direction is influenced by water well pumping, particularly during the irrigation season.

The contaminants of concern in groundwater consist of volatile organic compounds (VOCs) and explosives. The most prevalent VOC is Trichloroethene (TCE) and the most prevalent explosives are RDX and TNT. In some locations the VOCs and explosives plumes are co-mingled. The areal extent of the VOC plume is approximately 6 square miles, and the areal extent of the explosives plume is approximately 1.4 square miles.

1.2.2 Remedial Phase and Status

A Record of Decision (ROD) was completed on 4 August 2010 and the groundwater remedy is currently in the Remedial Design phase (at the time of the GSR evaluation). The selected groundwater remedy in the ROD is referred to as "Hydraulic Containment with Focused Extraction and Monitored Natural Attenuation". The remedy will include groundwater extraction and treatment for the semi-confined aquifer, and monitored natural attenuation (MNA) in the unconfined aquifer. The treated groundwater will be discharged to surface water (to a tributary of Big Sandy Creek) as a default option, though the Project Team is considering options to store treated water in basins to be created with a series of dams to provide opportunities for beneficial re-use including irrigation, aquifer recharge, and wildlife habitat.

The GSR Team was provided with a 30 Percent Design report and associated drawings ("Pre-Draft Design" dated 3 December 2010). This GSR evaluation was conducted after the 30 Percent Design and prior to the 60 Percent Design, and the schedule of the GSR evaluation was expedited so that the Project Team would receive the Draft GSR Report early enough to allow sufficient time for GSR findings or recommendations to potentially be included within the 60 Percent Design.

1.3 DOCUMENTS REVIEWED AND CALLS/MEETINGS CONDUCTED

The following project documents were reviewed for this evaluation:

- *Sitewide Groundwater Remediation, Comparison of Alternatives* (2 May 2008)
- *Final Record of Decision, Sitewide Groundwater* (Shaw, 4 August 2010)
- *Option 4b - Hydraulic Containment With Focused Extraction and Monitored Natural Attenuation, Extraction Wells With Pipeline Route* (Shaw, September 2010)
- *Optimization of Monitoring Well Placement For Potential RDX Breakthrough Detection in the Ogallala Aquifer* (SAIC, April 2008)
- *Groundwater Modeling Team Work Plan for Design of A Robust Optimal Pump and Treat System* (Internal team working copy, 7 October 2009)
- *Draft Final Treatability Study Report, Operable Unit 14* (IT Corporation, September 2000)
- *Progress Memorandum 2A, Model Parameter Uncertainty Analyses* (Shaw, 11 November 2010)
- *Progress Memorandum 2B, Preliminary Design of Long-Term Monitoring Network* (Shaw, 11 November 2010)
- *Pre-Draft Design Analysis Report, Extraction and Treatment System, Sitewide Groundwater Remediation, Operable Unit 14* (Shaw, 3 December 2010)
  {referred to herein as the "30 % Design"}
- *Advanced Review Copy, Progress Memorandum 1B, Design of Optimal P&T System and Pumping Schedule* (Shaw, 6 April 2010)

As per the GSR approach being implemented in the Study, an introductory conference call (referred to as the "Step 3" call) was conducted on 7 January 2011. Items discussed on this call included the following:

- The Project Team was provided an overview of the GSR Study and a summary of the steps included in each GSR evaluation, plus a preliminary list of GSR Best Management Practices (BMPs) that would be discussed later in the GSR evaluation.

- The schedule of the GSR evaluation was discussed within the context of how the GSR evaluation could best be integrated into the overall efforts and schedule of the Project Team.

- A date was set for the subsequent "Step 5" call, which would serve as a primary mechanism for the GSR Team and Project Team to exchange information and ideas.

Participants for the "Step 3" call are listed in Table 1-1.

Table 1-1
Step 3 Call Participants, 7 January 2011

Participants			
Name	**Organization**	**Phone**	**Email**
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A more detail conference call, referred to as the "Step 5" conference call, was conducted on 13 January 2011 and required approximately three hours. During this call the GSR Team used the list of GSR BMPs developed for the Study as an outline to ask questions to the Project Team and allow the Project Team to provide pertinent information to the GSR Team. Participants for the "Step 5" call are listed in Table 1-2.

Table 1-2
Step 5 Call Participants, 13 January 2011

Participants			
Name	**Organization**	**Phone**	**Email**
Carol Dona	EM CX	402.697.2582	Carol.L.Dona@usace.army.mil
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1.4 STRUCTURE OF THIS REPORT

This GSR evaluation report is structured as follows:

- Section 1: Introduction
- Section 2: Key GSR Findings
    - Review of BMPs
    - Quantitative Footprint Analysis for Baseline Option
    - Footprint Impacts for Selected Design Alternatives
    - Other Qualitative Considerations
- Section 3: GSR Recommendations
    - Recommendations Based on Quantitative Footprint Considerations
    - Recommendations to Further Evaluate Specific Alternatives
    - Other Qualitative Recommendations

Supporting information and calculations for quantitative aspects of the evaluation are provided in appendices, and spreadsheet files for the SiteWise tool are attached electronically.

2.0 KEY GSR FINDINGS

2.1 REVIEW OF BEST MANAGEMENT PRACTICES (BMPs)

2.1.1 BMP Tables Completed by GSR Team

The GSR Team and the Project Team used a list of GSR BMPs as an outline to exchange information and ideas pertinent to application of GSR practices for this pilot project. The GSR Team subsequently completed the BMP tables included in Appendix A, based on the data provided by the Project Team in the form of documents as well as discussions during the Step 5 conference call. Table 2-1 summarizes information entered on the BMP tables in Appendix A, specifically with respect to the number of BMPs that appear to be applicable for this pilot project, the number of BMPs that appear to be practical for this pilot project, the number of BMPs that have been implemented prior to this GSR evaluation, and the number of BMPs that may be associated with potential cost savings for this pilot project.

Table 2-1
Summary of BMP Applicability and Implementation from BMP Tables in Appendix A

	BMP Category								
	A. Planning	B. Characterization and/or Remedy Approach	C. Energy/Emissions Transportation	D. Energy/Emissions Equipment Use	E. Materials & Off-site Services	F. Water Resource Use	G. Waste Generation, Disposal, and Recycling	H. Land Use, Ecosystems, and Cultural Resources	I. Safety and Community
Total Number of BMPs	10	9	4	11	5	5	6	6	7
Number of Applicable BMPs	10	8	4	9	4	3	3	6	5
Number of Practical BMPs	9	7	1	4	2	0	1	4	4
Number of BMPs Implemented Prior to GSR Evaluation									
- Fully	5	2	0	1	1	0	0	0	0
- Partially	1	5	0	2	0	0	1	3	4
- Not Yet	3	0	1	1	1	0	0	1	0
Number of BMPs Likely to Result in Cost Savings	3	5	1	3	2	0	1	0	1

2.1.2 Key Findings Regarding BMPs

An overview of key findings regarding application of the BMPs to this pilot project is provided below.

- The Project Team has already considered many of the BMPs prior to this GSR evaluation, and has demonstrated significant effort and commendable progress for implementing GSR. Examples include the following:

    - Reports to date include a carbon footprint of remedy alternatives, and the pre-draft for the 60 Percent Design includes a planned chapter for "renewable energy and sustainability considerations".

    - The Project Team is actively pursuing options for beneficial use of treated water from the groundwater pump-and-treat system.

    - The Project Team is evaluating the potential to discharge treated water via gravity rather than with a discharge pump, which would reduce electricity usage and related environmental footprints.

    - A photovoltaic system currently powers the field office, and a feasibility study to evaluate potential for powering the remedy with wind power is planned.

    - A primary consideration for location of the treatment plant for the P&T system was to utilize land that was not favorable for other land use, thus preserving other land with greater land use potential.

    - Extensive modeling has been conducted to optimize the extraction rates for obtaining plume capture (i.e., to minimize the number of wells and their pumping rates).

    - The Project Team selected packed tower air strippers over tray aerators based on a comparison of energy use.

    - The Project Team is considering the use of an environmentally-friendly, non-phosphate dispersant that would reduce the number of acid washes for the air stripper, reducing potential exposure to hazardous chemicals.

    - The Project Team anticipates using telemetry to reduce the number of trips to the site during the subsequent O&M phase.

    - The Project Team plans to use native fill for backfill of piping runs rather than importing material.

    - Plume characterization has used direct push rather than permanent wells whenever possible to efficiently refine the interpreted contaminant distribution, and there are plans to use direct push in the proposed extraction well locations to confirm groundwater impacts prior to well drilling (to potentially avoid installing extraction wells in locations that are not significantly impacted by contaminants).

    - The proposed monitoring plan is streamlined to collect only those data required to evaluate remedy performance.

    - The Project Team plans to use local labor for construction and plant operation, which will reduce transportation requirements and provide benefits to local residents and/or businesses.

    - The Project Team has demonstrated consideration of cultural sites by locating potential dams (that would store treated water for beneficial re-use) to avoid a known cemetery.

- While going through the BMP list on the Step 5 call, the GSR Team suggested several items that the Project Team could consider moving forward. Some examples include the following:

    - Potentially generating renewable energy from the discharge of treated water (e.g., some sort of turbine if water can be designed to be discharged by gravity).

    - Incorporate language in the design to minimize engine idle times for heavy equipment during remedy construction.

    - Consider including potential purchase of Renewable Energy Certificates as part of the feasibility analysis that is currently planned for wind energy.

    - Have the architect look into passive lighting, sensors for lighting, and other design elements for the treatment building that might reduce energy consumption.

    - Consider use of coal combustion by-products as a re-cycled material that can be used for concrete.

- The Project Team identified that some BMPs are not practical to implement because of other project-specific constraints. Examples include the following:

    - The Project Team agreed that a BMP to perform construction during the best seasons is a good consideration to allow for longer work days and less exposure to cold weather, but indicated that schedule constraints will override those considerations.

    - The Project Team agreed that the discharge from the treatment plant would provide a good potential stream of water for heat exchange (for heating and/or cooling needs), but the building is not located near any buildings that could be served by such an approach and the treatment building will have minimal heating/cooling needs.

- Some BMPs are potentially applicable in a future remedial phase (system operation), but it is somewhat premature to consider them in detail during the Design Phase. Some examples include the following:

    - Include green specifications in the future O&M contract.

    - Utilize alternative fuels as part of the construction activities where possible.

2.2 QUANTITATIVE FOOTPRINT ANALYSIS FOR BASELINE OPTION

2.2.1 Overview of Baseline Option

The baseline remedy option involves the following components to restore groundwater to unrestricted use (see Figure 1-2 which is duplicated from Figure 3-7 of the 30 Percent Design):

- Installation of 20 new extraction wells (14 in the northeast plume and 6 in the southeast plume), in addition to the use of one existing well for groundwater extraction;

- Construction of a unified groundwater treatment plant, located between the northeast and southeast well networks (closer to the northeast well network);

- Construction of over 10 miles of extraction network piping between the extraction wells and the treatment building;

- Extraction of groundwater at a rate of 3,275 gpm from the 20 new wells and 1 existing well for 30 years (the distribution of individual pumping rates will be modified for each different five-year pumping period, but the total rate will be the same in each pumping period);

- Treatment of extracted groundwater with two packed-tower air strippers in parallel; and

- Discharge of treated water by force main to local surface water.

The Project Team is also considering the construction of dams to impound treated water to promote beneficial reuse of the treated water and/or infiltration of the water to the subsurface.

Input to the SiteWise tool and other supporting calculations are described in Appendix B.

2.2.2 Summary of Quantitative Footprint Results, Baseline Design

Table 2-2 summarizes the quantitative footprint results for this Baseline remedy design. Input to the SiteWise tool (Version 1) and other supporting calculations are described in Appendix B. The SiteWise files utilized for this portion of the analysis are supplied electronically ("Alternative 1").

Table 2-2
Summary of Quantitative Footprint for Baseline Design

GSR Parameter	Unit	Value
Environmental		
Energy – Total	MMBtu	829,690
Energy – Direct Scope 1	MMBtu	255,286
Energy – Indirect Scope 2	MMBtu	514085
Energy – Indirect Scope 3	MMBtu	60,320
% of Energy from Renewable Resources	%	negligible
Global warming potential – Total	Metric tons CO2e	68,382
Global warming potential – Direct Scope 1	Metric tons CO2e	130
Global warming potential – Indirect Scope 2	Metric tons CO2e	66,357
Global warming potential – Indirect Scope 3	Metric tons CO2e	1,895
Criteria air pollutant emissions	Metric tons (NOx+SOx+PM)	355
Hazardous air pollutant emissions	Lb	5,375
Potable water use	1,000s of gallons	Negligible
Other water use	1,000s of gallons	51,678,046
Refined materials use	Lbs	1,873,598
% of refined materials from recycled material	%	0%
Unrefined materials use	Ton	499
% of unrefined materials from recycled material	%	0%
Non-hazardous waste generation	Ton	Negligible
Hazardous waste generation	Ton	Negligible
% of potential waste that is recycled or reused	%	0%
Land transferred or made available for beneficial use	Acres	0
Existing ecosystem destruction	Acres	0
Time frame for land reuse	Years	0
Flexibility and breadth of options for reuse	see below	1
Economic		
Life-cycle Cost, Discounted (3% discount rate)	$	$46,142,993
Life-cycle Cost, Undiscounted	$	$60,120,000
Up-front Cost	$	$19,800,000
Societal		
Predicted number of injuries or fatalities for On-Site Worker	Number of injuries or fatalities	0.027
Predicted number of injuries or fatalities associated with transportation	Number of injuries or fatalities	0.17
One-Way Heavy Vehicle Trips through Res. Area	Trips	72

**Scale for flexibility and breadth of re-use options (greater GSR value with lower number, indicating more breadth and flexibility for potential re-use)*

1 - Unlimited re-use options
2 - Limited re-use options
3 - Only one re-use option

Table 2-2 divides total energy use and global warming potential into “direct” and “indirect” use and emissions. The following definitions are utilized for “direct” versus “indirect” energy use and global warming potential:

- Direct Scope 1: From sources that are owned or controlled by the reporting entity.
- Indirect Scope 2: Due to activities of the reporting entity, but occur at sources owned or controlled by another entity, from consumption of purchased electricity, heat or steam.
- Indirect Scope 3: Due to activities of the reporting entity, but occur at sources owned or controlled by another entity, other than Scope 2 (such as the extraction and production of purchased materials and fuels, transport-related activities in vehicles not owned or controlled by the reporting entity, outsourced activities, waste disposal, etc.

SiteWise Version 1 reports total energy use and total global warming potential, but does not sum the “direct” and “indirect” components. The user needs to track the distinction between “direct” and “indirect” components separately, based on information contained within the SiteWise spreadsheets. The separation of the total energy and global warming potential is documented in Appendix B, which describes SiteWise input and related calculations.

2.2.3 Key Findings from Quantitative Footprint Analysis, Baseline Design

Review of the SiteWise results and supporting calculations in Appendix B indicate the following key findings with respect to the Baseline remedy design:

- The energy, global warming potential, and criteria air pollutant emission footprints are dominated by the electricity use, which is associated with long-term operation of the P&T system. All other contributors to the energy, global warming potential, and criteria air pollutant emission (e.g., drill rig operation, heavy equipment, operation, and materials manufacturing) are negligible relative to the contribution due to electricity use.
- With respect to electricity, the extraction well pumps constitute approximately 87% of the electricity use, the air stripper blowers constitute approximately 10% of the electricity use, and the effluent pump constitutes approximately 2% of the electricity use.
- There is some renewable energy (solar) associated with the office, but it is considered to be negligible as a percentage of the overall energy usage associated with the remedy.
- The emission of hazardous air pollutants results primarily from the emission of untreated air stripper off-gas to the atmosphere. As discussed later, this could be addressed by switching from air stripping to liquid phase GAC, but this would add substantially to the life-cycle cost of the remedy.
- Potable water is generally not used by the remedy. Other water use is primarily (more than 99%) associated with the extraction of groundwater and not returning all of it to the subsurface. A small amount of the water use is calculated by SiteWise from electricity generation associated

with the use of the pumps and the blowers. The Project Team has been considering methods to incorporate recharge of some of the treated water to the subsurface.

- The primary use of refined materials is the more than 1 million pounds of HDPE for the extraction system and effluent piping. The concrete for the building foundation is also a substantial contributor (over 500,000 pounds) but much of this is aggregate (a relatively unrefined resource).

- The primary use of unrefined materials is the gravel for the base of the building foundation.

- The project does not involve significant non-hazardous or hazardous waste generation.

- The Project Team is limiting the impacts of the remedy on the surrounding land use by working with the landowner (such as locating the treatment building in a location not suitable for other land use). The active components of the remedy will be in place for approximately 30 years with substantial underground infrastructure but limited above-ground infrastructure.

- A table summarizing the calculation of life-cycle cost (discounted and undiscounted) is included in Appendix B.

    - The capital cost of $19.8M comes from the Table 5 in the ROD, which is included in Appendix B. This includes the direct costs (e.g., extraction system, piping, treatment plant, etc.) of $13.5M, indirect costs (e.g., procurement, project management, contractor mobilization and demobilization, design plans, etc.) of $4.5M, and Owner's supervision and administration of $1.8M.

    - The annual cost of $1.344M per year is also taken from Table 5 of the ROD, for the first 30 years of the remedy (the active remedy period).

    - Capital costs are assumed to occur in year 0, and annual costs are assumed to occur in years 1 to 30.

    - To determine net present value (NPV), a 3 percent discount rate is applied to future costs, which is consistent with the discount rate applied in the ROD.

    - NPV is calculated by discounting future costs to present-day dollars using the following equation:

$$PV = \frac{FV}{(1+i)^n} = C \times FV$$

PV is the present value
FV is the value in year "n" (i.e., future value)
i is the discount rate
C is the discount factor, which equals $1/(1+i)^n$

- The primary contributors to risk are 1) transportation for the treatment plant operator and 2) transportation of the HDPE for the piping systems.

2.3 FOOTPRINT IMPACTS OF SELECTED DESIGN ALTERNATIVES

The GSR Team has quantitatively evaluated impacts to footprint estimates that could result from the following design alternatives:

- Power the remedy with wind energy (Section 2.3.1)
- Use of variable frequency drives on air stripper blower motors (Section 2.3.2)
- Use of variable frequency drives on extraction pumps (Section 2.3.3)
- Change from air stripping to liquid GAC (Section 2.3.4)
- Build two treatment plants (Section 2.3.5)

These are discussed below, with supporting information provided in Appendices and in some cases with SiteWise spreadsheet files (attached electronically).

2.3.1 Power Remedy with Wind Energy

The energy, global warming potential, and criteria air pollutant emission footprints are dominated by the electricity use, which constitutes more than 90% of the energy use. Use of electricity generated from renewable resources could eliminate the emissions footprints. This is an option already being evaluated by the Project Team.

This option involves the use of on-site wind turbines to provide all of the approximately 73,800 MWh of the electricity estimated to be used by the remedy Baseline Option for O&M (pumps and blowers). It is assumed that the use of wind energy would involve no emissions of CO2e, NOx, SOx, PM, or HAPs and would not involve the use of water. Wind energy does not conserve electricity, but it uses energy from renewable resources and improves the GSR parameter for percentage of energy from renewable resources. Footprint for constructing the wind turbines is not considered.

Supporting information and calculations for the quantitative analysis performed for this alternative are presented in Appendix C-1, which also includes a summary sheet of the cost analysis.

Primary Footprints That Would Improve

The following table includes the approximate CO2e, NOx, SOx, and water footprints reductions calculated by SiteWise.

	Value Offset by Using Wind Power				
SiteWise Component	**Energy* (MMBtu)**	**CO2e (m. tons)**	**NOx (m. tons)**	**SOx (m. tons)**	**Water (gallons)**
Electric Pump Operation	690,000	59,000	120	200	34,000,000
Electric Blower Operation	81,000	7,000	14	24	4,000,000
Total	771,000	66,000	134	224	38,000,000

** Energy is not offset. Rather, this is the amount of energy that would be from renewable resources.*

SiteWise does not calculate the PM or HAPs associated with electricity generation; therefore, information for those footprints are not included in the table. The percent of energy from renewable would increase very significantly.

Primary Footprints That Would Worsen

The other environmental footprints would likely not be affected, except potential restrictions to the land occupied by the wind mills. It is expected that wind mill installation will include construction and transportation activities that could increase the risks to on-site workers, risks from transportation, and heavy vehicle trips in the area. The level of effort and resource for construction of the turbines depends on many factors that need to be fully evaluated in a forthcoming feasibility analysis, and these were not included in this analysis. Based on the remote nature of the site, visual and noise impacts are not likely to be a concern.

Cost Analysis

A cost spreadsheet is included in Appendix C-1. At this point the GSR Team has no way to estimate the capital costs of the Wind project. An estimate of $2M is entered in the cost sheet only to illustrate the concept of payback period. Annual cost savings are estimated based on a current electricity rate of $0.0658 per kWh which is the average retail price for electricity in Nebraska according to www.eia.gov. The annual electrical savings are calculated below based on the SiteWise output for kWh for the Baseline Option (over 30 years) divided by 30 to get an annual result:

- Pumps: 66,000,000 kWh x $0.0658/kWh / 30 = $144,760
- Blowers: 7,800,000 kWh x $0.0658/kWh / 30 = $ 17,108

Total annual savings is thus estimated at $162,000 per year, which is entered into the cost sheet. For the "fictitious" capital cost of $2M entered in the sheet, payback would occur in approximately 13 years with no discounting, or 16 years with discounting. The payback period would be higher or lower depending on the actual value for capital costs.

2.3.2 Use of Variable Frequency Drives (VFDs) on Air Stripper Blower Motors

The Project Team has not yet considered VFDs for the air stripper blowers. The motors will likely be oversized (a common practice to avoid unintentionally undersizing motors). The use of variable frequency drives would allow the motors to be run at the required speed rather than full speed, providing some efficiency. In addition, the variable frequency drives will allow the Project Team to reduce (or increase) the blower air flow rates as needed in the future to accommodate potential changes in the extraction rate and/or the influent concentrations.

The power required to operate the blowers is proportional to the cube of the pump or blower speed. Based on this relationship, the following equation is used to estimate the electricity used by a motor with a VFD.

$$kWh = \frac{HP \times L_V{}^3}{\eta_m \times \eta_v} \times 0.746 \times hours$$

kWh = kilowatt-hours of electricity

HP = horsepower
L_V *= % of VFD full load (or speed in Hertz divided by 60 Hertz)*
η_m *= motor efficiency (assume 85%)*
η_v *= efficiency of VFD (90% for VFD speed settings over 75% of full speed)*
hours = hours of operation over time frame of project

The blowers both have 20 HP motors. Based on the above equation and assuming the VFD can be set at 85% of full speed, the electricity use for the blowers with a VFD would be approximately 6,300,000 kWh. This results in a savings of approximately 1.5 million kWh over the course of the remedy.

Supporting information and calculations for the quantitative analysis performed for this alternative are presented in Appendix C-2, which also includes a summary sheet of the cost analysis.

Primary Footprints That Would Improve

The primary footprints that would be improved are energy use, CO2e, NOx, SOx, and water footprints. Based on the results from SiteWise, the following footprint reductions are estimated over the 30-year timeframe of the active remedy:

- Energy 16,000 MMBtu
- CO2e 1,300 metric tons
- NOx 2.6 metric tons
- SOx 4.5 metric tons
- Water 770,000 gallons

Primary Footprints That Would Worsen

None.

Cost Analysis

A cost sheet is included in Appendix C-2. The GSR Team estimates an upfront cost of $7,500 to furnish and install the VFDs during remedy construction. Annual cost savings are estimated based on a current electricity rate of $0.0658 per kWh which is the average retail price for electricity in Nebraska according to www.eia.gov. The annual electrical savings are calculated below based on the estimated electrical savings of 1,500,000 kWh divided by 30 to get an annual result:

- 1,500,000 kWh x $0.0658/kWh / 30 = $3,290 per year

Total annual savings is thus estimated at $3,300 per year, which is entered into the cost sheet. Payback would occur in approximately 3 years with and without discounting.

2.3.3 Use of Variable Frequency Drives (VFDs) on Extraction Pumps

Variable frequency drives also have the potential to greatly reduce energy usage associated with pumping. The head produced by a pump is the square of the pump speed and the flow rate is directly proportional to the pump speed. Because the extraction rate at each well is expected to vary over the course of the remedy, the extraction pumps need to be sized to provide the maximum extraction rate (i.e., the pumping rates are expected to vary over the course of the remedy in 5-year periods). During some pumping periods, however, the extraction rate at some wells will need to be reduced to allow capacity to increase at other wells. The input into SiteWise assumes 15 HP extraction pumps for 21 wells for a total of 315 HP for extraction well pumps. Using a Grundfos 230S150-5B or equivalent, this assumes that each well could pump between 50 gpm and 225 gpm. This is simplifying assumption. There is substantially more variation planned for some of the pumps.

A review of the pump curve modified by pump speed suggests that the pump could provide 155 gpm at an average total dynamic head of approximately 160 ft at 87% of the full pump speed. Based on the above equation, using a VFD and a pump speed of 87%, the electricity use for the extraction wells with VFDs would be approximately 55,783,000 kWh or 55,783 MWh over the course of the remedy. Compared to the baseline 66,000 MWh for pumps throttled with a valve, using these assumptions, a VFD yields a savings of approximately 10,217,000 kWh or 10,217 MWh over the course of the remedy.

Supporting information and calculations for the quantitative analysis performed for this alternative are presented in Appendix C-3, which also includes a summary sheet of the cost analysis.

Primary Footprints That Would Improve

The primary footprints that would be improved are energy use, CO2e, NOx, SOx, and water footprints. Based on the results from SiteWise, the following footprint reductions are estimated over the 30-year timeframe of the active remedy:

- Energy 110,000 MMBtu
- CO2e 9,100 metric tons
- NOx 18 metric tons
- SOx 31 metric tons
- Water 5,200,000 gallons

Primary Footprints That Would Worsen

None.

Cost Analysis

A cost sheet is included in Appendix C-3. The GSR Team estimates an upfront cost of $63,000 (or $3,000 each) to furnish and install the VFDs during remedy construction. Annual cost savings are estimated based on a current electricity rate of $0.0658 per kWh which is the average retail price for electricity in Nebraska according to www.eia.gov. The annual electrical savings are calculated below based on the estimated electrical savings of 10,217,000 kWh divided by 30 to get an annual result:

- 10,217,000 kWh x $0.0658/kWh / 30 = $22,409 per year

Total annual savings is thus estimated at $22,400 per year, which is entered into the cost sheet. Payback would occur in approximately 3 years with and without discounting.

2.3.4 Change From Air Stripping to Liquid Phase GAC

Liquid phase GAC could be used to treat the extracted water in place of air stripping. One technical advantage is that, unlike air stripping, the GAC could treat both the VOCs and the explosives. Currently the air stripping option assumes that RDX influent concentrations will be low enough to not require treatment, and a fallback would be to pre-treat specific wells for RDX with carbon prior to stripping. Use of liquid GAC would add the flexibility to treat RDX at the treatment plant if needed. This alternative is being considered by the Project Team.

In the 30 Percent Design (Table A-5) the Project Team considered the potential use of GAC in place of air stripping and estimated approximately 1.668 million pounds of GAC would be used over the life of the remedy. A GAC system might also require less frequent system checks than an air stripper system (the 30 Percent Design suggests that visits might be reduced by half). The electricity for the air stripper blowers would be eliminated. However, carbon replacements would require transport.

Supporting information and calculations for the quantitative analysis performed for this alternative are presented in Appendix C-4, which also includes a summary sheet of the cost analysis. The GSR Team performed quantitative analysis for both virgin carbon and regenerated carbon.

A summary of various environmental footprint parameters from the SiteWise results is provided below.

GSR Parameter	Baseline Remedy (O&M Only)	Virgin GAC Option (O&M Only)	Regenerated GAC Option (O&M Only)
Energy (MMBtu)	768,000	774,000	688,000
CO2e (metric tons)	66,438	64,329	60,206
Risk (On-Site)	0	0	0
Risk (Transportation)	0.0831	0.064	0.064

Note that SiteWise does not provide footprint information for NOx, SOx, and water for GAC. Therefore, changes in these footprints are not known and are not shown in the above table.

Primary Footprints That Would Improve

GAC would eliminate emission of hazardous air pollutants to the atmosphere via the air stripper off-gas. Also, GAC would not aerate the water and thus not increase pH. This could potentially decrease the possibility of scaling and potentially eliminate the need for adding a sequestering agent which would add to remedy footprints (not quantified). Based on the SiteWise results summarized above, the energy footprint will be slightly reduced if regenerated carbon is used, but slightly increased if virgin carbon is used (more energy is required to activate the virgin carbon). For both virgin and regenerated carbon, the CO2e declines only slightly (because the blowers are only as small contributor to overall carbon footprint). The SiteWise results indicate a slight decrease in transportation risk that apparently results from fewer overall trips to the site.

Primary Footprints That Would Worsen

Material usage would increase due to the use of approximately 1.668 million pounds of GAC over the life of the project. There would be increased heavy truck traffic, though that is not a major concern for this project. The overall energy use would increase slightly if virgin carbon is used.

Cost Analysis

A cost sheet is included in Appendix C-4. Based on Tables A-1 and A-5 of the 30 Percent Design, the capital cost of the GAC would be approximately $150,000 more than the air stripping. The estimated difference in annual costs for changing to carbon is as follows:

- Carbon cost is an additional $127,900 per year from Table A-6 of the 30 Percent Design

- Electricity is a reduction because the blowers are no longer needed. The total electric use of the blowers is 7,800,000 kWh over 30 years. Savings per year is

  7,800,000 kWh x $0.0658/kWh / 30 = $17,108

- Assume 24 visits per year are cut by 4 hours each , and assume a labor rate of $50/hr, yields labor savings per year of 24 x 4 x $50 = $4,800

Thus total annual change is an increase of $127,900 - $17,108 - $4,800 = approximately $106,000/yr.

Since there is both a capital cost and an increase in annual cost, there will be no payback period. In this case, the footprint reductions do not appear to be significant enough to justify the increase in cost, so this alternative does not appear to be favorable from a GSR perspective unless elimination of the air stripper effluent is considered to be problematic (that does not appear to be the case).

2.3.5 Build Two Treatment Plants

The treatment plant is located between the two extraction networks requiring substantial piping between the networks and the building. This extra piping involves substantial materials usage, equipment use, and transportation for construction. The GSR Team estimates that using one treatment system for each extraction network and optimizing the location of those buildings could reduce the piping by 1,800 feet for the Northeast system and 18,600 feet for the Southeast system. Although two buildings would be required, each building would be smaller than the current single building that is planned, such that the footprint associated with building construction would be relatively similar (as long as suitable land is available).

Supporting information and calculations for the quantitative analysis performed for this alternative are presented in Appendix C-5, which also includes a summary sheet of the cost analysis.

Primary Footprints That Would Improve

This could reduce HDPE use by almost 600,000 pounds (over 50%) and eliminate almost half of the travel, transportation, and equipment use for pipe construction. This approach would substantially reduce head loss in the piping network, and combined with using VFDs on the extraction wells, using two buildings could potentially reduce the project electricity usage by over 12,000 MWh (over 15%). This approach also eliminates substantial underground infrastructure that will need to be maintained for over

30 years and eventually abandoned.

Primary Footprints That Would Worsen

Two separate areas of land are required to be set aside for long-term above-ground structures. This may or may not conflict with the land owner's use of the property. Also, the treatment plant operator will need to visit two systems instead of one. While this may include two stops for the operator, it is not expected to add significantly to mileage or time on site.

Cost Analysis

A cost sheet is included in Appendix C-5. The cost of two treatment buildings instead of one could result in a capital cost increase of over $877,500, and the cost of furnishing and installing the VFDs will likely cost approximately $63,000. However, the following cost reductions are expected:

- Reducing the length of pipe installed by over 20,000 feet could result in a savings of approximately $1,550,400

- Annual savings from reduced electricity usage would be on the order of $27,000 per year.

In net, there is a capital cost decrease of approximately $609,500, and an annual cost decrease of approximately $27,000 per year. The life-cycle savings is approximately $1.1 million discounted and $1.4 million undiscounted.

2.4 OTHER QUALITATIVE CONSIDERATIONS

2.4.1 Ecological Considerations Regarding Potential Impoundments for Treated Water

During the "Step 5" conference call conducted for this GSR study, the GSR Team asked if the potential impoundments for treated water that are under consideration (to be created by earthen dams) would be considered to potentially cause negatively impacts to the local ecosystem by disturbing existing land and or surface water features. The Project Team explained that these impoundments are actually viewed as potentially positive features from an ecological perspective by project stakeholders including the Natural Resource District. The reason is that these reservoirs will likely promote additional net recharge to groundwater, which is seen as beneficial. In addition, these impoundments will be located closer to irrigation needs than the existing reservoir located further downstream. Finally, these impoundments would be filled with water all year, with some of the water siphoned off for beneficial reuse when needed. Thus, new wetland areas would be created. In summary, it appears that such impoundments, if implemented, would be considered beneficial to the local ecology rather than a potential disturbance to existing ecosystems.

2.4.2 Considerations Regarding Irrigation with Treated and Untreated Water

During the "Step 5" conference call conducted for this GSR study, USACE EM CX asked if there had been consideration of the potential buildup of RDX in soil if treated water is used for irrigation, since the Baseline Option utilizes air stripping which does not remove the low levels of RDX in the influent. It was stated during the call that this was not expected to be an issue because RDX readily photo-degrades. EM CX also indicated they believe there have been calculations performed that illustrate this will not ultimately be a concern. EM CX indicated that some formal calculations should likely be presented as part of the Remedial Design. However, this was not addressed further as part of this GSR study. Similarly, there was brief discussion during the "Step 5" call that it could be technically feasible to spray irrigate untreated water certain times of the year, because the VOCs would likely be adequately volatized during the irrigation. Based on information subsequently provided by the Project Team, spray irrigation was evaluated as a process option in the 2004 Feasibility Study. Studies conducted in the Hastings area indicated that VOCs can be removed from water through spray irrigation. However, the FS eliminated spray irrigation as a potential remediation technology because of its ineffectiveness in removing nitroaromatics. Also on the "Step 5" call, concern about supplying untreated water to the public (the farmers using the water), and potential liability if equipment malfunctioned and untreated water was applied to crops, was mentioned. This option was not addressed further as part of this GSR study.

3.0 GSR RECOMMENDATIONS

These are recommendations provided by the GSR Team for the consideration of the Project Team, and potentially other project stakeholders. These are not requirements, and implementation should ultimately be decided by the Project Team based on their concurrence regarding GSR benefits and/or other project-specific constraints.

3.1 RECOMMENDATIONS BASED ON QUANTIFIED FOOTPRINT CONSIDERATIONS

This section includes recommendations that the GSR Team believes are favorable from a GSR perspective, and for which some quantitative evaluation of GSR footprint was performed as part of this GSR study. These recommendations are summarized in the form of tracking tables, as follows:

Table Number	Recommendation
3-1	3.1.1 - Include VFDs for Air Stripper Blower Motors
3-2	3.1.2 - Use of Variable Frequency Drives (VFDs) on Extraction Pumps
3-3	3.1.3 - Build Two Treatment Plants

The tracking table format allows the implementation status of the recommendation to be updated as the project progresses.

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Table 3-1
Tracking Table for Recommendation 3.1.1

<table>
<tr><td colspan="2">Recommendation:

3.1.1 - Include VFDs for Air Stripper Blower Motors</td><td>Current Date:
2/5/11
Date of Original Recommendation:
2/5/11</td></tr>
<tr><td colspan="3">Basis for Recommendation (Include discussion of cost impacts and value if appropriate):

Reduces footprints for energy use, CO2e, criteria pollutants, and water used to generate electricity. Requires minimal up-front cost, and has a payback period of approximately 3 years. Does not appear to have any significant negative impacts.</td></tr>
<tr><td colspan="3">Resources Conserved:
☐ Hazardous air pollutants ☒ GHG emissions (CO2e) ☒ Energy ☒ Water ☐ Waste
☒ Criteria pollutants ☐ Safety/Community ☐ Materials ☐ Land-use</td></tr>
<tr><td colspan="2">Qualitative Net Cost Impact Over 5 Years, No Discounting

☐ Cost Increase ☒ Cost Savings
☐ Cost Neutral ☐ N/A</td><td>☐ Recommended action otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☒ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="3">Attachment(s) to report with footprint assumptions and calculations:

This alternative is summarized in Section 2.3.2 of this GSR Evaluation Report, and supporting information and/or calculations are provided in Appendix C-2 of this GSR Evaluation Report. SiteWise spreadsheets utilized for evaluating this alternative are attached electronically (SiteWise Alternative 2 directory, as explained in Appendix C-2)</td></tr>
<tr><td>Implementation Status:

☐ Fully
☐ Partially
☒ Not Yet
☐ Not Planned</td><td colspan="2">Explanation of Status:

This is a new recommendation for the Project Team to consider during the 60 Percent Design.</td></tr>
</table>

Table 3-2
Tracking Table for Recommendation 3.1.2

<table>
<tr><td colspan="2">Recommendation:

3.1.2 - Include VFDs for Extraction Pumps</td><td>Current Date:
2/5/11

Date of Original Recommendation:
2/5/11</td></tr>
<tr><td colspan="3">Basis for Recommendation (Include discussion of cost impacts and value if appropriate):

Reduces footprints for energy use, CO2e, criteria pollutants, and water used to generate electricity. Requires minimal up-front cost, and has a payback period of approximately 3 years. Does not appear to have any significant negative impacts.</td></tr>
<tr><td colspan="3">Resources Conserved:
☐ Hazardous air pollutants ☒ GHG emissions (CO2e) ☒ Energy ☒ Water ☐ Waste
☒ Criteria pollutants ☐ Safety/Community ☐ Materials ☐ Land-use</td></tr>
<tr><td colspan="2">Qualitative Net Cost Impact Over 5 Years, No Discounting

☐ Cost Increase ☒ Cost Savings
☐ Cost Neutral ☐ N/A</td><td>☐ Recommended action otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☒ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="3">Attachment(s) to report with footprint assumptions and calculations:

This alternative is summarized in Section 2.3.3 of this GSR Evaluation Report, and supporting information and/or calculations are provided in Appendix C-3 of this GSR Evaluation Report. SiteWise spreadsheets utilized for evaluating this alternative are attached electronically (SiteWise Alternative 2 directory, as explained in Appendix C-3)</td></tr>
<tr><td>Implementation Status:

☐ Fully
☐ Partially
☒ Not Yet
☐ Not Planned</td><td colspan="2">Explanation of Status:

This is a new recommendation for the Project Team to consider during the 60 Percent Design.</td></tr>
</table>

Table 3-3
Tracking Table for Recommendation 3.1.3

<table>
<tr><td colspan="2" rowspan="2">Recommendation:

3.1.3 - Build Two Treatment Plants</td><td>Current Date:
2/5/11</td></tr>
<tr><td>Date of Original Recommendation:
2/5/11</td></tr>
<tr><td colspan="3">Basis for Recommendation (Include discussion of cost impacts and value if appropriate):

Reduces footprints for energy use, CO2e, criteria pollutants, water used to generate electricity, refined materials use, risk to on-site workers, and risks due to transportation. Results in significant upfront cost savings and saves approximately $27,000 per year in electricity costs. Only apparent negative impact is that two parcels of land are required for two treatment plants instead of one parcel for one treatment plant.</td></tr>
<tr><td colspan="3">Resources Conserved:
☐ Hazardous air pollutants ☒ GHG emissions (CO2e) ☒ Energy ☒ Water ☐ Waste
☒ Criteria pollutants ☒ Safety/Community ☒ Materials ☐ Land-use</td></tr>
<tr><td>Qualitative Net Cost Impact Over 5 Years, No Discounting

☐ Cost Increase ☒ Cost Savings
☐ Cost Neutral ☐ N/A</td><td colspan="2">☐ Recommended action otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="3">Attachment(s) to report with footprint assumptions and calculations:

This alternative is summarized in Section 2.3.5 of this GSR Evaluation Report, and supporting information and/or calculations are provided in Appendix C-5 of this GSR Evaluation Report. SiteWise spreadsheets utilized for evaluating this alternative are attached electronically (SiteWise Alternative 5 directory, as explained in Appendix C-5).</td></tr>
<tr><td>Implementation Status:

☐ Fully
☐ Partially
☒ Not Yet
☐ Not Planned</td><td colspan="2">Explanation of Status:

This is a new recommendation for the Project Team to consider during the 60 Percent Design.</td></tr>
</table>

3.2 RECOMMENDATIONS TO FURTHER EVALUATE SPECIFIC ALTERNATIVES

This section includes recommendations to further evaluate specific alternatives to the Baseline Option that may have merit with respect to GSR, and for which some quantitative evaluation was performed as part of this GSR study. These alternatives require further evaluation for one or more of the following reasons:

- More detailed analysis is needed with respect to the GSR parameters because of uncertainty in key design elements

- More detailed analysis is needed with respect to potential costs and/or cost savings

- Although some GSR parameters are improved, one or more other GSR parameters are negatively impacted, resulting in a tradeoff that is not straightforward

These alternatives that are recommended for further consideration are summarized in the form of tracking tables, as follows:

Table Number	Recommendation
3-4	3.2.1 - Consider Powering Remedy with Wind Energy

The "tracking table" format allows the implementation status of these alternatives to be updated as the project progresses.

The further evaluation of this alternative is beyond the scope of the current GSR evaluation, and should be addressed by the Project Team at their discretion. The information provided herein (particularly in the attachments referenced on the tracking table for each alterative) provides a useful starting point for any further evaluation.

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Table 3-4
Tracking Table for Recommendation 3.2.1

<table>
<tr><td colspan="2">Recommendation:

3.2.1 - Consider Powering Remedy with Wind Energy</td><td>Current Date:
2/5/11
Date of Original Recommendation:
2/5/11</td></tr>
<tr><td colspan="3">Basis for Recommendation (Include discussion of cost impacts and value if appropriate):

Improves nature of energy use to much higher percentage from renewable sources, and eliminates CO2e, criteria pollutants, and water used to generate electricity. Also would be utilizing renewable energy for the remedy, which is a positive. This alternative requires more evaluation to determine up-front costs that would be required (to allow payback period to be calculated more accurately), and to evaluate technical feasibility. Up-front cost, though not quantified here, would be expected to be in the millions of dollars.</td></tr>
<tr><td colspan="3">Resources Conserved:
☐ Hazardous air pollutants ☒ GHG emissions (CO2e) ☒ Energy ☒ Water ☐ Waste
☒ Criteria pollutants ☐ Safety/Community ☐ Materials ☐ Land-use</td></tr>
<tr><td colspan="2">Qualitative Net Cost Impact Over 5 Years, No Discounting

☒ Cost Increase ☐ Cost Savings
☐ Cost Neutral ☐ N/A</td><td>☐ Recommended action otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☒ > $500,000</td></tr>
<tr><td colspan="3">Attachment(s) to report with footprint assumptions and calculations:

This alternative is summarized in Section 2.3.1of this GSR Evaluation Report, and supporting information and/or calculations are provided in Appendix C-1 of this GSR Evaluation Report. SiteWise spreadsheets utilized for evaluating this alternative are attached electronically (SiteWise Alternative 1 directory, as explained in Appendix C-1)</td></tr>
<tr><td>Implementation Status:

☐ Fully
☐ Partially
☒ Not Yet
☐ Not Planned</td><td colspan="2">Explanation of Status:

This is a new recommendation for the Project Team to consider during the 60 Percent Design.</td></tr>
</table>

3.3 OTHER QUALITATIVE RECOMMENDATIONS

This section includes qualitative recommendations that were identified from the analysis of BMPs, but for which no quantitative evaluation was performed as part of this GSR evaluation. This section only includes BMPs that were not previously implemented by the Project Team, and represents those BMPs that the GSR Team thinks have the most merit and/or are easiest to implement. These recommendations are also presented in a tracking table format which allows the implementation status of the recommendation to be updated as the project progresses, and those tables reference the pertinent BMPs in Appendix A. However, unlike the previous recommendations, these do not reference attachments with information or calculations pertaining to quantitative evaluation of GSR footprints, since no such calculations were performed.

These recommendations are summarized in the form of tracking tables, as follows:

Table Number	Recommendation
3-5	3.3.1 - Potentially generating renewable energy from the discharge of treated water
3-6	3.3.2 - Incorporate language in the design to minimize engine idle times for heavy equipment during remedy construction
3-7	3.3.3 - Consider including potential purchase of Renewable Energy Certificates as part of the feasibility analysis that is currently planned for wind energy
3-8	3.3.4 - Have the architect look into passive lighting, sensors for lighting, and other design elements for the treatment building that might reduce energy consumption
3-9	3.3.5 - Consider use of coal by-products as a re-cycled material that can be used for concrete
3-10	3.3.6 - In future remedy phases, include green specifications in the O&M contract
3-11	3.3.7 - In future remedy phases, utilize alternative fuels as part of the construction activities where possible

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Table 3-5
Tracking Table for Recommendation 3.3.1

<table>
<tr><td colspan="2">Recommendation:

3.3.1 - From BMP D-6: Potentially generating renewable energy from the discharge of treated water (e.g., some sort of turbine if water can be designed to be discharged by gravity)</td><td>Current Date:
2/5/11

Date of Original Recommendation:
2/5/11</td></tr>
<tr><td colspan="3">Basis for Recommendation (Include discussion of cost impacts and value if appropriate):

This can lower environmental footprints by reducing electricity usage, and increase the use of renewable energy used for the treatment system. It will only be a possibility if treated water can be discharge via gravity rather than an effluent pump, which is something the Project Team is looking into (the 30 Percent Design does include an effluent pump). This would likely have a payback over the course of the remedy, buy likely would not have a payback of less than 5 years.

In general, the use of micro-turbines to generate electricity from low-head, large-flow settings is possible. There are generators that produce 3 kW of power from head drops of only 12-15 feet with 2200 gpm flow. See http://www.solar-systems.ca/water-turbine.php. The City of San Bernardino uses similar turbines to generate power at the end of long runs of downhill piping. This project potentially has 12 feet of head and 3000 gpm (~6.5 cfs).</td></tr>
<tr><td colspan="3">Resources Conserved:
☒ Hazardous air pollutants ☒ GHG emissions (CO2e) ☒ Energy ☒ Water ☐ Waste
☒ Criteria pollutants ☐ Safety/Community ☐ Materials ☐ Land-use</td></tr>
<tr><td>Qualitative Net Cost Impact Over 5 Years, No Discounting

☒ Cost Increase ☐ Cost Savings
☐ Cost Neutral ☐ N/A</td><td colspan="2">☐ Recommended action otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☒ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="3">Attachment(s) to report with footprint assumptions and calculations:

This is a qualitative recommendation based on consideration of BMPs, and the impacts to GSR footprints for this recommendation were not quantified.</td></tr>
<tr><td>Implementation Status:

☐ Fully
☐ Partially
☒ Not Yet
☐ Not Planned</td><td colspan="2">Explanation of Status:

This is a new recommendation for the Project Team to consider during the 60 Percent Design.</td></tr>
</table>

Table 3-6
Tracking Table for Recommendation 3.3.2

Recommendation: *3.3.2 - From BMP D-1: Incorporate language in the design to minimize engine idle times for heavy equipment during remedy construction*	Current Date: 2/5/11 Date of Original Recommendation: 2/5/11
Basis for Recommendation (Include discussion of cost impacts and value if appropriate): *This will reduce energy use and emissions if implemented. There is negligible cost to implement this recommendation.*	
Resources Conserved: ☒ Hazardous air pollutants ☒ GHG emissions (CO2e) ☒ Energy ☐ Water ☐ Waste ☒ Criteria pollutants ☐ Safety/Community ☐ Materials ☐ Land-use	
Qualitative Net Cost Impact Over 5 Years, No Discounting ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A	☐ Recommended action otherwise required? If checked, required by:
Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000	
Attachment(s) to report with footprint assumptions and calculations: *This is a qualitative recommendation based on consideration of BMPs, and the impacts to GSR footprints for this recommendation were not quantified.*	
Implementation Status: ☐ Fully ☐ Partially ☒ Not Yet ☐ Not Planned	Explanation of Status: *This is a new recommendation for the Project Team to consider during the 60 Percent Design.*

Table 3-7
Tracking Table for Recommendation 3.3.3

<table>
<tr><td colspan="2">Recommendation:

3.3.3 - From BMP D-7: Consider including potential purchase of Renewable Energy Certificates as part of the feasibility analysis that is currently planned for wind energy</td><td>Current Date:
2/5/11

Date of Original Recommendation:
2/5/11</td></tr>
<tr><td colspan="3">Basis for Recommendation (Include discussion of cost impacts and value if appropriate):

If wind energy proves to be infeasible based on cost analysis or technical factors, then the purchase of Renewable Energy Certificates (RECs) is a possible mechanism to offset some portion of the footprints associated with electricity used for the remedy operation. Purchase of RECS supports the development of renewable energy at other locations, and provides the purchaser with the right to claim the footprint offsets. Although it does add to annual costs, there are no capital costs. Stakeholders may determine the footprint offsets justify the additional annual cost for purchasing the RECs.</td></tr>
<tr><td colspan="3">Resources Conserved:
☐ Hazardous air pollutants ☒ GHG emissions (CO2e) ☐ Energy ☐ Water ☐ Waste
☒ Criteria pollutants ☐ Safety/Community ☐ Materials ☐ Land-use</td></tr>
<tr><td>Qualitative Net Cost Impact Over 5 Years, No Discounting

☒ Cost Increase ☐ Cost Savings
☐ Cost Neutral ☐ N/A</td><td colspan="2">☐ Recommended action otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="3">Attachment(s) to report with footprint assumptions and calculations:

This is a qualitative recommendation based on consideration of BMPs, and the impacts to GSR footprints for this recommendation were not quantified.</td></tr>
<tr><td>Implementation Status:

☐ Fully
☐ Partially
☒ Not Yet
☐ Not Planned</td><td colspan="2">Explanation of Status:

This is a new recommendation for the Project Team to consider during the 60 Percent Design.</td></tr>
</table>

Table 3-8
Tracking Table for Recommendation 3.3.4

<table>
<tr><td colspan="2">Recommendation:

3.3.4 - From BMP D-8: Have the architect look into passive lighting, sensors for lighting, and other design elements for the treatment building that might reduce energy consumption</td><td>Current Date:
2/5/11

Date of Original Recommendation:
2/5/11</td></tr>
<tr><td colspan="3">Basis for Recommendation (Include discussion of cost impacts and value if appropriate):

This will reduce electricity use and emissions if implemented.</td></tr>
<tr><td colspan="3">Resources Conserved:
☒ Hazardous air pollutants ☒ GHG emissions (CO2e) ☒ Energy ☒ Water ☐ Waste
☒ Criteria pollutants ☐ Safety/Community ☐ Materials ☐ Land-use</td></tr>
<tr><td>Qualitative Net Cost Impact Over 5 Years, No Discounting

☐ Cost Increase ☐ Cost Savings
☒ Cost Neutral ☐ N/A</td><td colspan="2">☐ Recommended action otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☒ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="3">Attachment(s) to report with footprint assumptions and calculations:

This is a qualitative recommendation based on consideration of BMPs, and the impacts to GSR footprints for this recommendation were not quantified. Assumed to be cost neutral based on capital costs offset by reduced electricity, but detailed calculations were not performed.</td></tr>
<tr><td>Implementation Status:

☐ Fully
☐ Partially
☒ Not Yet
☐ Not Planned</td><td colspan="2">Explanation of Status:

This is a new recommendation for the Project Team to consider during the 60 Percent Design.</td></tr>
</table>

Table 3-9
Tracking Table for Recommendation 3.3.5

<table>
<tr><td colspan="2" rowspan="2">Recommendation:

3.3.5 - From BMP E-1: Consider use of coal by-products as a re-cycled material that can be used for concrete</td><td>Current Date:
2/5/11</td></tr>
<tr><td>Date of Original Recommendation:
2/5/11</td></tr>
<tr><td colspan="3">Basis for Recommendation (Include discussion of cost impacts and value if appropriate):

This will increase the percent of materials that come from recycled materials. The GSR Team is uncertain about the cost impact and has checked "cost neutral".</td></tr>
<tr><td colspan="3">Resources Conserved:
☐ Hazardous air pollutants ☐ GHG emissions (CO2e) ☐ Energy ☐ Water ☐ Waste
☐ Criteria pollutants ☐ Safety/Community ☐ Materials ☐ Land-use</td></tr>
<tr><td>Qualitative Net Cost Impact Over 5 Years, No Discounting

☐ Cost Increase ☐ Cost Savings
☒ Cost Neutral ☐ N/A</td><td colspan="2">☐ Recommended action otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="3">Attachment(s) to report with footprint assumptions and calculations:

This is a qualitative recommendation based on consideration of BMPs, and the impacts to GSR footprints for this recommendation were not quantified.</td></tr>
<tr><td>Implementation Status:

☐ Fully
☐ Partially
☒ Not Yet
☐ Not Planned</td><td colspan="2">Explanation of Status:

This is a new recommendation for the Project Team to consider during the 60 Percent Design.</td></tr>
</table>

Table 3-10
Tracking Table for Recommendation 3.3.6

<table>
<tr><td colspan="2" rowspan="2">Recommendation:

3.3.6 - From BMP A-7: In future remedy phases, include green specifications in the O&M contract</td><td>Current Date:
2/5/11</td></tr>
<tr><td>Date of Original Recommendation:
2/5/11</td></tr>
<tr><td colspan="3">Basis for Recommendation (Include discussion of cost impacts and value if appropriate):

This will improve the likelihood that green practices are implemented as part of the contract. The cost of implementing this should be negligible.</td></tr>
<tr><td colspan="3">Resources Conserved:
☒ Hazardous air pollutants ☒ GHG emissions (CO2e) ☒ Energy ☒ Water ☒ Waste
☒ Criteria pollutants ☒ Safety/Community ☒ Materials ☐ Land-use</td></tr>
<tr><td>Qualitative Net Cost Impact Over 5 Years, No Discounting

☐ Cost Increase ☐ Cost Savings
☒ Cost Neutral ☐ N/A</td><td colspan="2">☐ Recommended action otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☒ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="3">Attachment(s) to report with footprint assumptions and calculations:

This is a qualitative recommendation based on consideration of BMPs, and the impacts to GSR footprints for this recommendation were not quantified.</td></tr>
<tr><td>Implementation Status:

☐ Fully
☐ Partially
☒ Not Yet
☐ Not Planned</td><td colspan="2">Explanation of Status:

This is a new recommendation for the Project Team to consider during the 60 Percent Design.</td></tr>
</table>

Table 3-11
Tracking Table for Recommendation 3.3.7

<table>
<tr><td colspan="2">Recommendation:

3.3.7 - From BMP D-3: In future remedy phases, utilize alternative fuels as part of the construction activities where possible</td><td>Current Date:
2/5/11
Date of Original Recommendation:
2/5/11</td></tr>
<tr><td colspan="3">Basis for Recommendation (Include discussion of cost impacts and value if appropriate):

Potentially reduces GHG emissions. Likely a slight cost increase.</td></tr>
<tr><td colspan="3">Resources Conserved:
☐ Hazardous air pollutants ☒ GHG emissions (CO2e) ☐ Energy ☐ Water ☐ Waste
☐ Criteria pollutants ☐ Safety/Community ☐ Materials ☐ Land-use</td></tr>
<tr><td>Qualitative Net Cost Impact Over 5 Years, No Discounting

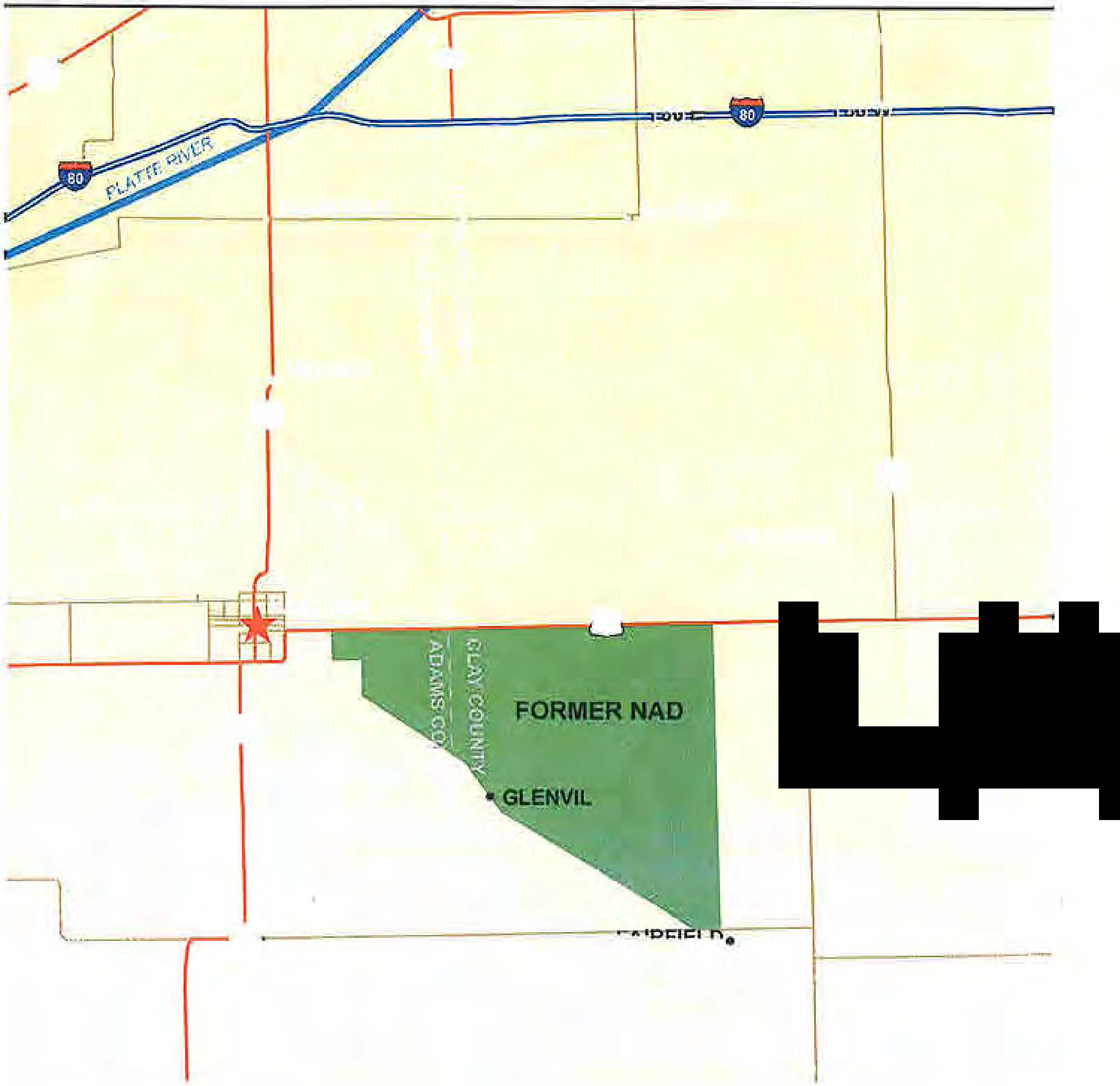
☒ Cost Increase ☐ Cost Savings
☐ Cost Neutral ☐ N/A</td><td colspan="2">☐ Recommended action otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="3">Attachment(s) to report with footprint assumptions and calculations:

This is a qualitative recommendation based on consideration of BMPs, and the impacts to GSR footprints for this recommendation were not quantified.</td></tr>
<tr><td>Implementation Status:

☐ Fully
☐ Partially
☒ Not Yet
☐ Not Planned</td><td colspan="2">Explanation of Status:

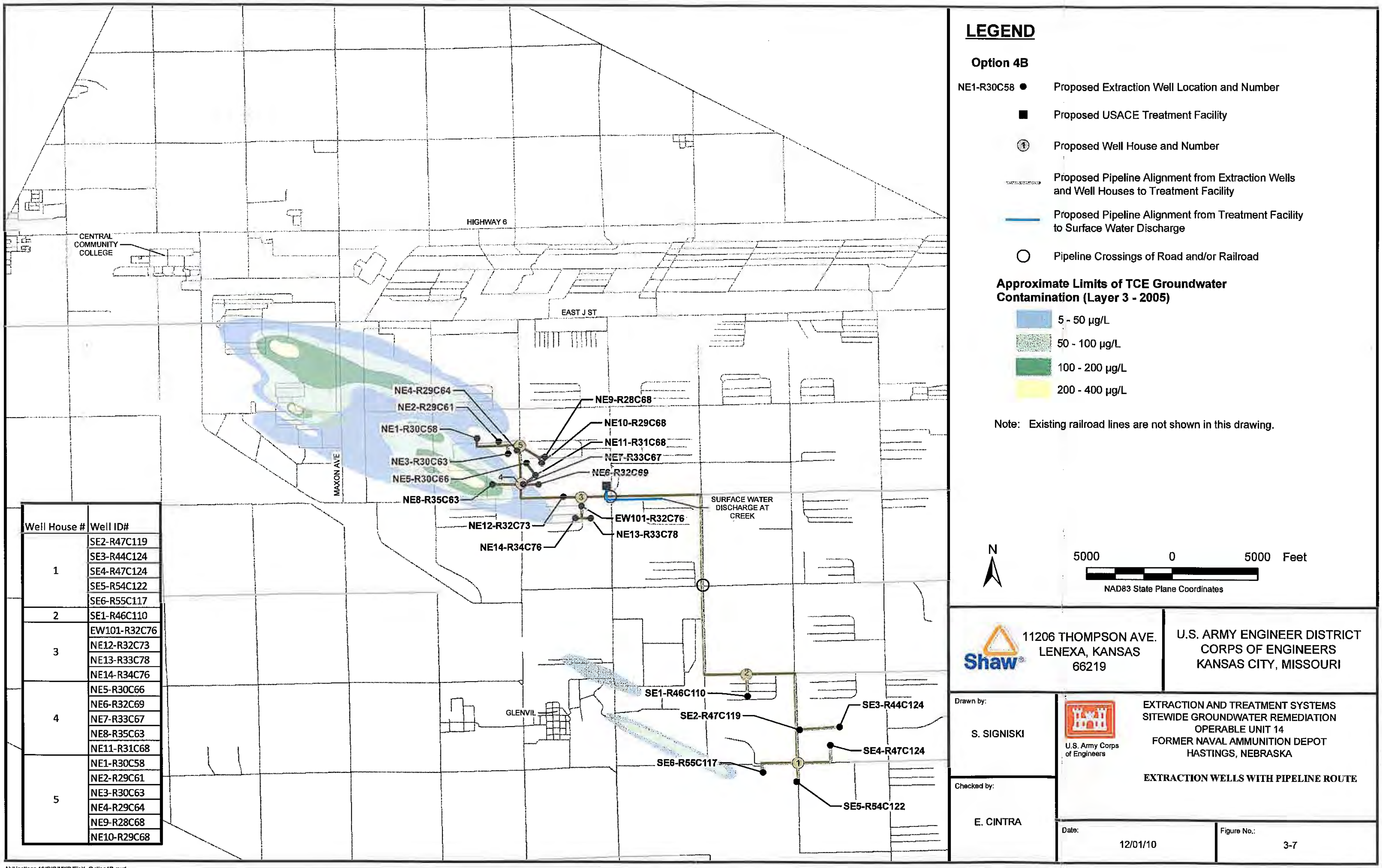
This is a new recommendation for the Project Team to consider during the 60 Percent Design.</td></tr>
</table>

FIGURES



Shaw

Figure 1-1: Vicinity Map (From Figure 1-1 of 30 Percent Design by Shaw)



Well House #	Well ID#
1	SE2-R47C119
	SE3-R44C124
	SE4-R47C124
	SE5-R54C122
	SE6-R55C117
2	SE1-R46C110
3	EW101-R32C76
	NE12-R32C73
	NE13-R33C78
	NE14-R34C76
4	NE5-R30C66
	NE6-R32C69
	NE7-R33C67
	NE8-R35C63
	NE11-R31C68
5	NE1-R30C58
	NE2-R29C61
	NE3-R30C63
	NE4-R29C64
	NE9-R28C68
	NE10-R29C68

Figure 2-1: Extraction Wells With Pipeline Route, Baseline Option
(From Figure 3-7 of 30 Percent Design by Shaw)

APPENDIX A

Best Management Practice (BMP) Tables

BMP Category A: Planning

<table>
<tr><td colspan="3">BMP A-1: Develop a culture of GSR within the project team and encourage GSR ideas from project staff</td><td>Date: 2/3/11
☒ Applicable
☒ Evaluated
☒ Practical</td></tr>
<tr><td>Implemented?
("N/A" if "Practical" not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☒ Economic ☒ Social</td><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="2">Resources Conserved:
☒ Hazardous air pollutants ☒ Energy ☒ Waste
☒ Criteria pollutants ☒ Materials ☒ Safety/Community
☒ GHG emissions (CO2e) ☒ Water ☒ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

This BMP has already been implemented. For example, solar panels have been installed to offset the electricity used to power the site office. Emissions calculations have also been done for this project.</td></tr>
</table>

<table>
<tr><td colspan="3">BMP A-2: Incorporate a section on GSR in project meetings, work plans, and reports</td><td>Date: 2/3/11
☒ Applicable
☒ Evaluated
☒ Practical</td></tr>
<tr><td>Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☒ Partially ☐ Not Yet ☐ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☒ Economic ☒ Social</td><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="2">Resources Conserved:
☒ Hazardous air pollutants ☒ Energy ☐ Waste
☒ Criteria pollutants ☒ Materials ☐ Safety/Community
☒ GHG emissions (CO2e) ☒ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

Section 6.0 of the 30% Design Report, titled "Renewable Energy and Sustainability Considerations", has been set aside for this purpose. Implementing this BMP has added some cost, but not a significant amount (estimated less than $10K).</td></tr>
</table>

BMP Category A: Planning

BMP A-3: Identify and periodically update a list of key stakeholders and their concerns with respect to GSR considerations	**Date:** 2/3/11 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☒ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Active discussions with stakeholders (USDA as the landholder and Little Blue Natural Resource District) have taken place regarding the installation of dams and reservoirs. The USDA is also very interested in the potential for wind turbines at the site, and an FS is currently being conducted. The National Guard may also be interested in sustainable activities at their training site, and would likely be supportive of infrastructure being on their land. The EPA has a GSR checklist (including alternative energy) that the team is filling out. There is some uncertainty about the payback period for alternative energy.

BMP A-4: Schedule activities for appropriate seasons and/or time of day to reduce delays caused by weather conditions and fuel needed for heating or cooling Examples: - Work at night in summer to avoid heat stress - Perform field activities in summer to take advantage of longer daylight	**Date:** 2/3/11 ☒ Applicable ☒ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☒ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Due to delays in the ROD, the timeline for design and construction is tight. This will cause some inefficiency with regard to planning activities for the appropriate season, since in this case funding and the construction schedule take precedence over efficiency. An attempt will be made to plan construction activities for the appropriate time of year.

BMP A-5: Prepare, store, and distribute documents electronically		**Date:** 2/3/11 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☒ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A	
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000	
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☐ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:	
Notes (including discussion of possible value of implementing the BMP): *Electronic copies of project documents are distributed along with hard copies. In some cases hard copies are required, but the project team should contact stakeholders and ask if this could be replaced with an electronic deliverable.*		

BMP A-6: Utilize teleconferences rather than meetings when feasible		**Date:** 2/3/11 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A	
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000	
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:	
Notes (including discussion of possible value of implementing the BMP): *This BMP has already been implemented. Only a few meetings are conducted per year for RAB meetings. Some meetings with the NDEQ also take place in Lincoln. Otherwise, teleconferencing is typically preferred.*		

BMP A-7: Incorporate green specifications into solicitations and contracts Examples: - Follow pertinent green procurement policies - Select hotel chains with "green" policies - Select laboratories that utilize renewable energy	**Date:** 2/3/11 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☒ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☒ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

It is too early in the process for this BMP to be applied. Shaw is already under contract for the project design and construction, but this BMP should be considered in subcontract agreements for construction subcontractors, construction contractors, suppliers of materials and services, and O&M.

BMP A-8: Integrate schedules to allow for resource sharing and fewer days of field mobilization	**Date:** 2/3/11 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☒ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☐ Waste ☒ Criteria pollutants ☐ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

It is too early in the process for this BMP to be applied, but it should be considered prior to construction.

BMP A-9: Explore multiple site reuse options, including those that include some restriction of site reuse and related resource conservation	**Date:** 2/3/11 ☒ Applicable ☒ Evaluated ☒ Practical

Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☒ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

All project infrastructure is being planned so as not to limit use of the property, and the treatment plant will be located in an otherwise unusable area to avoid impacts to current land use. In addition, groundwater is being cleaned up to unrestricted standards, as the site is in a groundwater use area.

BMP A-10: Conduct thorough review of project documents and historical records to minimize required scope of investigation Examples: - IRP projects: determine if there are previous aquifer tests that can be used for groundwater modeling rather than conducting new aquifer tests - MMRP projects: perform careful review of historic documents, aerial photographs, and other existing information to reduce the footprint of land that needs to be disturbed for thorough investigation and remediation - MMRP projects: use IRP sampling data to supplement and enhance the MMRP field program (if available)	**Date:** 2/3/11 ☒ Applicable ☒ Evaluated ☒ Practical

Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Work to date has included review of historic documents.

BMP Category B: Characterization and/or Remedy Approach

BMP B-1: Develop and routinely update a conceptual site model (CSM) to use as a basis for making remedy decisions	**Date:** 2/3/11 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☒ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☒ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

This BMP has already been put into practice in the extensive site modeling that has taken place. This is described in the modeling section in the 30% Design Report.

BMP B-2: Perform frequent optimization evaluations to improve efficiency of current or planned actions and/or develop alternative remedial approaches that might shorten remedy duration or otherwise improve the net environmental benefit of the remedy	**Date:** 2/3/11 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☒ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☒ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

This has been addressed during the feasibility study and design. The modeling that has been done for this project also includes optimization that has resulted in fewer extraction wells and a lower construction rate.

BMP Category B: Characterization and/or Remedy Approach

<table>
<tr><td colspan="3">BMP B-3: Use appropriate characterization or remedy approach based on site conditions
Examples:
- Consider in-situ and passive remedy options that offer adequate protectiveness
- Consider in-situ bioremediation if conditions are already anaerobic and constituents are conducive to reductive dechlorination
- Compare source removal versus in-situ and ex-situ remedial options
- Consider different technologies for impacted areas with higher and lower concentrations
- Use realistic times to remedy closeout (i.e., estimations through modeling) rather than assumed remedy timeframes (e.g., 30 years), which is often used for evaluation of FS alternatives
- MMRP projects: evaluate man-portable DGM instruments versus vehicle-towed array (VTA) instruments and inclusion of detector-aided reconnaissance (DAR)</td><td>Date: 2/3/11

☒ Applicable
☒ Evaluated
☒ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☒ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☒ Economic ☒ Social</td><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="2">Resources Conserved:
☒ Hazardous air pollutants ☒ Energy ☒ Waste
☒ Criteria pollutants ☒ Materials ☒ Safety/Community
☒ GHG emissions (CO2e) ☒ Water ☒ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

Monitored natural attenuation (MNA) as a standalone remedy was considered for this project but rejected. The source area can be addressed with other approaches, but the broad areal extent of the plume leads to pump and treat as the most effective option (though other alternatives were considered). Air sparging was also looked at as a potential treatment option.</td></tr>
</table>

<table>
<tr><td colspan="3">BMP B-4: Establish decision points to trigger a change from one technology to another or from one remedy alternative to another
Examples:
- Change vapor treatment from thermal oxidation to granular activated carbon (GAC) media based on flow rates and concentrations
- Remove a treatment polishing step if influent to that step already meets discharge criteria
- Move to Monitored Natural Attenuation (MNA) if specific concentration thresholds in groundwater are met</td><td>Date: 2/3/11

☒ Applicable
☒ Evaluated
☒ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☐ Fully ☒ Partially ☐ Not Yet ☐ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☒ Economic ☒ Social</td><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
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<tr><td colspan="2">Resources Conserved:
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☒ Criteria pollutants ☒ Materials ☒ Safety/Community
☒ GHG emissions (CO2e) ☒ Water ☒ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

The project team plans to have active pumping in the semi-confined aquifer only up until the point in time when turning off the extraction wells will still satisfy POCs. RDX treatment is not planned; separate wellhead treatment will be implemented if needed. These decisions will be updated along with the revised modeling over the course of the remedy. The modeling will be used to consider when wells can be turned off, even before all groundwater meets goals.</td></tr>
</table>

BMP Category B: Characterization and/or Remedy Approach

BMP B-5: Focus sampling efforts to meet objectives of the specific remedial phase (e.g., sampling during O&M should be focused on evaluating remedy performance and not on thorough plume characterization) Examples: - Eliminate sampling parameters as appropriate - Reduce sampling frequency as appropriate - Reduce sample locations as appropriate - Enhance monitoring program as appropriate - MMRP projects: consider Incremental Sampling Methodology (ISM) versus discrete sampling for MC characterization	**Date:** 2/3/11 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☒ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☒ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

The planned monitoring is streamlined. Water levels are measured to validate the model-predicted capture, and water quality sampling is conducted at key downgradient locations based on model simulations to monitor for potential failures in plume capture. Sampling is to be initially conducted semi-annually, followed by a shift to annual or less frequent sampling. The project team will continue to work with regulatory agencies on this matter.

BMP B-6: Consider real-time measurements and dynamic work plans to reduce mobilizations and improve effectiveness of investigation efforts

Date: 2/3/11

Examples:

- Field test kits (e.g., test kits for sulfate)
- Field screening instruments (e.g., x-ray fluorescence for lead or photoionization detectors for volatile organics)
- Drive point sensor technologies (e.g., membrane interface probe or "MIP")
- Visual staining or odor
- Establish excavation extent based on real-time data collected as excavation proceeds and use GPS to accurately delineate excavation areas
- MMRP projects: use GPS and/or the same equipment that was used for detection to confirm anomaly signatures prior to excavating
- MMRP projects: consider incorporating field screening methods (e.g., X-ray fluorescence, EXPRAY and explosives test kits, as appropriate or applicable) into the field program to refine sampling locations and reduce the quantities of samples submitted for off-site laboratory analysis

☒ Applicable
☒ Evaluated
☒ Practical

Implemented?
("N/A" if "Practical" not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☒ Economic ☒ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☒ Hazardous air pollutants ☒ Energy ☒ Waste
☒ Criteria pollutants ☒ Materials ☒ Safety/Community
☒ GHG emissions (CO2e) ☒ Water ☒ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Early on in the project, direct push was used to collect samples rather than installing monitoring wells, saving millions of dollars. This has reduced uncertainties about plume distribution over time to minimize remedial action. For the planned construction, direct push samples will be collected at proposed extraction well locations to confirm the model's predictions. Unexpected results can then be addressed before the installation of the well. The project team will also consider installing wells before finalizing the treatment plan.

BMP Category B: Characterization and/or Remedy Approach

BMP B-7: Consider use of existing site structures/infrastructure or mobilization of temporary structures versus new construction Examples: - Buildings (e.g., for treatment building or field office) - Concrete slabs or foundations - Wells - Existing excavations for storm water control	**Date:** 2/3/11 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☒ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☒ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

The old train depot was considered for the treatment plant, but this was deemed not feasible. The depot site will be used, if not the building. One of the extraction wells was installed in 2005 for another test, and the project team has decided to re-use it for the remedy. Another extraction well to the south was also considered, but ultimately could not be used effectively.

BMP B-8: Establish project-specific decision points to limit extent of remediation Examples: - Project-specific cleanup levels based on a site-specific risk assessment (coordinated with risk assessment experts) rather than generic cleanup levels, if it results in lower footprints for key parameters and is acceptable to all stakeholders - MMRP projects: dig stopping rules and anomaly prioritization/detection criteria to minimize false positives	**Date:** 2/3/11 ☒ Applicable ☒ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

A baseline risk assessment was conducted, but MCLs will be used since cleanup to unrestricted use is planned.

BMP Category B: Characterization and/or Remedy Approach

BMP B-9: Consider leaving in place structures whose removal is not necessary (i.e., foundations, underground pillars, etc.)	**Date:** 2/3/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

No removal of existing structures or infrastructure will be required.

BMP Category C: Energy/Emissions – Transportation

BMP C-1: Reduce the number of trips for personnel Examples: - Encourage carpooling - Use telemetry systems and webcams to remotely transmit data directly to project offices to avoid trips	**Date:** 2/3/11 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☒ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☐ Waste ☒ Criteria pollutants ☐ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

The treatment plant is being planned for remote operation. One visit by a local subcontractor is planned per week (~20 miles round trip assumed from nearby Grand Island). The bidders for subcontracting will also most likely be local, and carpooling will be encouraged.

BMP C-2: Reduce the number of trips and/or volume for transported materials, equipment, or waste Examples: - Transfer full loads by consolidating shipments from vendors and/or shipments to disposal sites (also share shipments with neighbors if feasible) - Purchase more concentrated chemicals to reduce transportation weight and/or volume	**Date:** 2/3/11 ☒ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☐ Waste ☒ Criteria pollutants ☐ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

It is too early in the process for this BMP to be applied, but it should be considered prior to construction.

BMP Category C: Energy/Emissions – Transportation

BMP C-3: Reduce trip lengths Examples: - Dispose of waste at closest appropriate facility - Purchase materials, equipment, and services from local vendors - Use locally produced supplies - Select most efficient transportation route	**Date:** 2/3/11 ☒ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☐ Waste ☒ Criteria pollutants ☐ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

It is too early in the process for this BMP to be applied, but it should be considered prior to construction.

Minimal waste will need to be transported to disposal facilities.

The well casing and screens will most likely come from Aurora, NE.

The project team plans to use local contractors. They could also request that vendors supply information on their suppliers, but low bid requirements could be a constraint.

BMP C-4: Use alternate fuels or other options for transportation when possible Examples: - Compressed natural gas - Biodiesel blends - Ethanol blends - Hybrid and/or electric - Rail lines versus trucks - Use a fuel efficient passenger car rather than a pickup truck if task allows	**Date:** 2/3/11 ☒ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☒ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☒ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☒ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

It is too early in the process for this BMP to be applied, but it should be considered prior to construction.

BMP Category D: Energy/Emissions – Equipment Use

<table>
<tr><td colspan="3">BMP D-1: Consider and implement approaches to minimize engine idle times</td><td>Date: 2/3/11
☒ Applicable
☐ Evaluated
☐ Practical</td></tr>
<tr><td>Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☐ Not Yet ☐ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social</td><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
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<tr><td colspan="2">Resources Conserved:
☒ Hazardous air pollutants ☒ Energy ☐ Waste
☒ Criteria pollutants ☐ Materials ☒ Safety/Community
☒ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

It is too early in the process for this BMP to be applied, but it should be considered prior to construction and could potentially be included in design documents.</td></tr>
</table>

<table>
<tr><td colspan="3">BMP D-2: Ensure peak operating efficiency of equipment to reduce energy use and emissions
Examples:
- Perform preventative maintenance and operate equipment per manufacturer instructions
- Perform retrofits involving low-maintenance multi-stage filters for cleaner engine exhaust
- Use synthetic oil to extend operating life (and reduce waste oil)
- Purchase newer equipment with reduced emissions</td><td>Date: 2/3/11
☒ Applicable
☐ Evaluated
☐ Practical</td></tr>
<tr><td>Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
☒ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☐ Economic ☐ Social</td><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="2">Resources Conserved:
☐ Hazardous air pollutants ☒ Energy ☐ Waste
☒ Criteria pollutants ☐ Materials ☐ Safety/Community
☒ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

It is too early in the process for this BMP to be applied, but it should be considered prior to construction.</td></tr>
</table>

BMP Category D: Energy/Emissions – Equipment Use

BMP D-3: Use alternate fuel options for equipment when possible
Examples:
- Compressed natural gas
- Biodiesel
- Ethanol blends
- Ultra-low sulfur diesel, wherever available (and as required by engines with PM traps)

Date: 2/3/11
☒ Applicable
☐ Evaluated
☐ Practical

Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☐ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☐ Hazardous air pollutants ☒ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☒ GHG emissions (CO2e) ☐ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

It is too early in the process for this BMP to be applied, but it should be considered prior to construction.

BMP D-4: Select appropriate equipment and/or power source for the job
Examples:
- Avoid using large excavators for small earthmoving projects
- Use direct push methods when possible to reduce drilling duration
- Compare potential use of electricity versus battery versus generator

Date: 2/3/11
☒ Applicable
☒ Evaluated
☒ Practical

Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☒ Partially ☐ Not Yet ☐ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☒ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☒ Hazardous air pollutants ☒ Energy ☐ Waste
☒ Criteria pollutants ☐ Materials ☐ Safety/Community
☒ GHG emissions (CO2e) ☐ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

The project team considered either a packed tower or tray for treatment, but ultimately decided on a packed tower due to the need for increased HP on a blower for the tray. The site team is also evaluating the placement of the packed tower (indoors vs. outdoors with heating tracing). This BMP will also be considered for construction equipment at the appropriate point in the remedial process.

Also, the project team is considering if it is possible to discharge treated water via gravity versus using a discharge pump, which would save electricity and reduce associated environmental footprints.

BMP Category D: Energy/Emissions – Equipment Use

BMP D-5: Use variable frequency drives on motors (e.g., pumps, blowers), or replace oversized motors with properly sized motors

Date: 2/3/11

[x] Applicable
[x] Evaluated
[x] Practical

Implemented? ("N/A" if "Practical" not checked)	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
[ ] Fully [x] Partially [ ] Not Yet [ ] N/A	[ ] Cost Increase [x] Cost Savings [ ] Cost Neutral [ ] N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):	Level of Up-Front Investment Included in 5 Year Cost Impact:
[x] Environmental [x] Economic [ ] Social	[ ] Negligible [ ] < \$10,000 [x] \$10,001 - \$50,000 [ ] \$50,001 - \$100,000 [ ] \$100,001 - \$500,000 [ ] > \$500,000

Resources Conserved:
[x] Hazardous air pollutants [x] Energy [ ] Waste
[x] Criteria pollutants [ ] Materials [ ] Safety/Community
[x] GHG emissions (CO2e) [ ] Water [ ] Land-use

[ ] BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

The air stripper feed pump will have a VFD, but the project team has not considered VFDs on the air stripper blowers, which may be worth considering if water flow rates are not relatively constant. The feasibility of VFDs for extraction wells is still being investigated.

BMP D-6: Identify options for generating renewable energy for direct use in the remedy and/or for alternate use at or near the project site

Examples:

- Solar, wind, landfill gas (microturbines), combined heat and power, geothermal heat exchange
- Applications for remote areas such as solar pumps or solar flares (if demand is not continuous, the need for a battery backup may be avoided)
- Generate power or heat exchange from water to be discharged

Date: 2/3/11

[x] Applicable
[ ] Evaluated
[ ] Practical

Implemented? ("N/A" if "Practical" not checked)	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
[ ] Fully [ ] Partially [ ] Not Yet [x] N/A	[ ] Cost Increase [ ] Cost Savings [ ] Cost Neutral [ ] N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):	Level of Up-Front Investment Included in 5 Year Cost Impact:
[x] Environmental [ ] Economic [ ] Social	[ ] Negligible [ ] < \$10,000 [ ] \$10,001 - \$50,000 [ ] \$50,001 - \$100,000 [ ] \$100,001 - \$500,000 [ ] > \$500,000

Resources Conserved:
[x] Hazardous air pollutants [x] Energy [ ] Waste
[x] Criteria pollutants [ ] Materials [ ] Safety/Community
[x] GHG emissions (CO2e) [ ] Water [ ] Land-use

[ ] BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Solar panels are being used for the office.

The feasibility of installing wind turbines on the property is being evaluated.

The heat from the water and equipment could supply direct use geothermal. Extraction water could be used for heating and cooling buildings, but there are currently no other buildings in the near vicinity.

The project team should also consider generating hydropower from discharge water.

BMP Category D: Energy/Emissions – Equipment Use

<table>
<tr><td colspan="2">BMP D-7: Consider purchase of renewable energy certificates to offset emissions from the remedial activities</td><td>Date: 2/3/11
☒ Applicable
☐ Evaluated
☐ Practical</td></tr>
<tr><td>Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A</td><td colspan="2">Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☐ Economic ☐ Social</td><td colspan="2">Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td>Resources Conserved:
☐ Hazardous air pollutants ☒ Energy ☐ Waste
☒ Criteria pollutants ☐ Materials ☐ Safety/Community
☒ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Notes (including discussion of possible value of implementing the BMP):

The project team should consider including a cost-benefit analysis of renewable energy certificates versus wind turbines in the wind feasibility study.</td></tr>
</table>

<table>
<tr><td colspan="2">BMP D-8: Design/modify housing required for above-ground treatment components for energy-efficiency
Examples:
- Passive lighting
- Compact fluorescent lighting (CFL) or light-emitting diode (LED) lighting
- Timers and/or motion control sensors for lighting
- Shading
- Minimize heating and cooling needs (building size, insulation, etc.)</td><td>Date: 2/3/11
☒ Applicable
☒ Evaluated
☒ Practical</td></tr>
<tr><td>Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☒ Not Yet ☐ N/A</td><td colspan="2">Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☐ Economic ☐ Social</td><td colspan="2">Level of Up-Front Investment Included in 5 Year Cost Impact:
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<tr><td>Resources Conserved:
☒ Hazardous air pollutants ☒ Energy ☐ Waste
☒ Criteria pollutants ☐ Materials ☐ Safety/Community
☒ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Notes (including discussion of possible value of implementing the BMP):

The project team is currently considering using insulation to reduce heating requirements (enough to prevent freezing). The team plans to have the architect consider ways to implement this BMP in the treatment building design.</td></tr>
</table>

BMP Category D: Energy/Emissions – Equipment Use

BMP D-9: For remedies that involve groundwater or air extraction, optimize extraction to reduce flow rates (potentially beneficial with respect to energy use, materials usage, water resources, waste disposal, etc.)	**Date:** 2/3/11 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☐ Waste ☒ Criteria pollutants ☐ Materials ☐ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP has already been implemented with the modeling optimization conducted to date.*	

BMP D-10: Consider pulsing for extraction of water or air to maximize mass removal per unit of time or energy, by extracting higher concentrations	**Date:** 2/3/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Implementation of this BMP would not be practical due to the dilute nature of the plume.*	

BMP Category D: Energy/Emissions – Equipment Use

<table>
<tr><td colspan="3">BMP D-11: Run electrical equipment during times of lower electric demand if possible (this does not reduce energy use but could lower cost and also can lower stress on the energy grid during periods of peak demand)</td><td>Date: 2/3/11
☐ Applicable
☐ Evaluated
☐ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
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<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
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☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="2">Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

This BMP is not applicable due to continuous operating requirements.</td></tr>
</table>

BMP Category E: Materials & Off-Site Services

BMP E-1: Use materials that are made from recycled materials

Examples:

- Steel
- Asphalt
- Plastics
- Concrete

Date: 2/3/11

☒ Applicable ☐ Evaluated ☐ Practical

Implemented? (“N/A” if “Practical” not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☒ Waste ☐ Criteria pollutants ☒ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Recycled riprap will be used. The project team has not yet considered using coal by-products for concrete, thought fly ash from a nearby power plant could potentially be used. The team will also need to check if this is allowed in Nebraska.

BMP E-2: Optimize the amount of materials used

Examples:

- Experiment with different material amounts/doses
- Consider alternate materials
- Use timers or feedback loops and process controls for dosing
- MMRP projects: minimize quantities of donor explosives for MEC destruction

Date: 2/3/11

☒ Applicable ☐ Evaluated ☐ Practical

Implemented? (“N/A” if “Practical” not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☒ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

The project team is attempting to size piping for each section of pipe based on maximum flow expected in each management period rather than using the maximum flow expected for each pipe section throughout the project flow so as not to oversize pipes. They are doing a cost analysis to compare HP requirements for pumping compared to the cost of the conveyance piping system.

The GSR study indicates that using two separate, optimally located treatment systems would reduce materials usage for piping. The project team indicated that it was considering the addition of a sequestering agent to process water during O&M. Optimizing this dosage would also help minimize materials usage.

BMP Category E: Materials & Off-Site Services

<table>
<tr><td colspan="3">BMP E-3: Utilize less refined materials when feasible
Examples:
- Limestone instead of sodium hydroxide for pH adjustment
- Native fill instead of select fill</td><td>Date: 2/3/11
[x] Applicable
[x] Evaluated
[x] Practical</td></tr>
<tr><td>Implemented? ("N/A" if "Practical" not checked)
[x] Fully [ ] Partially [ ] Not Yet [ ] N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
[ ] Cost Increase [x] Cost Savings [ ] Cost Neutral [ ] N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
[x] Environmental [ ] Economic [ ] Social</td><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
[x] Negligible [ ] < $10,000 [ ] $10,001 - $50,000
[ ] $50,001 - $100,000 [ ] $100,001 - $500,000 [ ] > $500,000</td></tr>
<tr><td colspan="2">Resources Conserved:
[ ] Hazardous air pollutants [ ] Energy [ ] Waste
[ ] Criteria pollutants [x] Materials [ ] Safety/Community
[ ] GHG emissions (CO2e) [ ] Water [ ] Land-use</td><td colspan="2">[ ] BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):
The project team plans to use native fill, which is typically used for bedding in this area.</td></tr>
</table>

<table>
<tr><td colspan="3">BMP E-4: Identify opportunities for using by-products or "waste" materials from local sources in place of refined chemicals or materials
Examples:
- Cheese whey, molasses, compost, or off-spec food products for inducing anaerobic conditions
- Crushed concrete for use as fill
- Concrete from coal combustion byproducts</td><td>Date: 2/3/11
[x] Applicable
[x] Evaluated
[x] Practical</td></tr>
<tr><td>Implemented?
("N/A" if "Practical" not checked)
[ ] Fully [ ] Partially [x] Not Yet [ ] N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
[ ] Cost Increase [x] Cost Savings [ ] Cost Neutral [ ] N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
[x] Environmental [ ] Economic [ ] Social</td><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
[x] Negligible [ ] < $10,000 [ ] $10,001 - $50,000
[ ] $50,001 - $100,000 [ ] $100,001 - $500,000 [ ] > $500,000</td></tr>
<tr><td colspan="2">Resources Conserved:
[ ] Hazardous air pollutants [ ] Energy [ ] Waste
[ ] Criteria pollutants [x] Materials [ ] Safety/Community
[ ] GHG emissions (CO2e) [ ] Water [ ] Land-use</td><td colspan="2">[ ] BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):
Coal waste products could be used for concrete, and crushed concrete could be used rather than gravel.</td></tr>
</table>

BMP Category E: Materials & Off-Site Services

BMP E-5: Reduce demand on Publicly Owned Treatment Works (POTWs) Examples: - Discharge treated water to groundwater or to surface water rather than POTW - Minimize amount of water requiring treatment	**Date:** 2/3/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? (“N/A” if “Practical” not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

This BMP is not applicable for this project.

BMP Category F: Water Resource Use

BMP F-1: Minimize water consumption Examples: - Sensors to turn off water when not needed - Low flow fittings - Minimize water needs for irrigation (landscape choices, use of mats and mulch)	**Date:** 2/3/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP is not applicable for this project.*	

BMP F-2: Preferentially use less refined water resources when feasible Examples: - Use extracted groundwater instead of potable water for chemical blending - Capture and store rain/storm water for future use - Employ rumble grates with a closed-loop gray-water washing system	**Date:** 2/3/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP is not applicable for this project.*	

BMP Category F: Water Resource Use

BMP F-3: Use extracted and treated water for beneficial purposes Examples: - Irrigation - Potable water - Industrial process water	**Date:** 2/3/11 ☒ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☒ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *The site team is evaluating the use of dams to impound treated water and facilitate reuse by the landowner and/or infiltration to groundwater. The landowner would need to provide the necessary infrastructure to actually use the treated water.*	

BMP F-4: Promote groundwater recharge Examples: - Recharge extracted and treated water when beneficial uses of the water are not identified and reinjection is practical - Minimize site area covered by impervious surfaces to reduce runoff and maximize infiltration (unless such capping is a specific component of the remedial action)	**Date:** 2/3/11 ☒ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☒ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *The site team is evaluating the use of dams to impound treated water and facilitate reuse by the landowner and/or infiltration to groundwater. The landowner would need to provide the necessary infrastructure to actually use the treated water.* *A partial purpose of the impoundments would be to promote groundwater recharge. Injection wells would require more infrastructure and present maintenance issues.*	

BMP Category F: Water Resource Use

BMP F-5: Maintain water quality by preventing nutrient loading to surface water or groundwater Examples: - Use phosphate-free detergents instead of organic solvents or acids to decontaminate sampling equipment (if not required for some contaminants)	**Date:** 2/3/11 ☒ Applicable ☐ Evaluated ☐ Practical

Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☒ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

The project team is looking into a non-phosphate sequestering agent/dispersant (SK-2000 by Pristine Water Solutions). This would reduce the number of acid washes needed, and the use of a non-phosphate agent would reduce nutrient loading to surface water and groundwater.

BMP Category G: Waste Generation, Disposal, and Recycling

BMP G-1: Minimize drill cuttings and all other investigation derived waste (including personal protection equipment)

Examples:

- Direct push or sonic drilling to reduce drill cuttings
- Low-flow sampling or passive diffusion bags (if applicable) to reduce purge water
- When possible place drill cuttings on-site rather than off-site disposal

Date: 2/3/11

☒ Applicable ☒ Evaluated ☒ Practical

Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☒ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

The project team plans to use mud rotary or reverse rotary to drill ~18 to 19 wells. Drill cuttings are typically spread on the surface, as is development water.

BMP G-2: Segregate excavated soil in pre-planned staging areas so that "clean" material can be deposited on-site and/or reused rather than transported for off-site disposal

Date: 2/3/11

☐ Applicable ☐ Evaluated ☐ Practical

Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

This BMP is not applicable for this project. No waste requires offsite disposal.

BMP Category G: Waste Generation, Disposal, and Recycling

BMP G-3: Consider on-site treatment and re-use of soil instead of off-site disposal

Examples:
- Land farming
- Above ground soil vapor extraction (SVE)

Date: 2/3/11

☐ Applicable
☐ Evaluated
☐ Practical

Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

This BMP is not applicable for this project.

BMP G-4: Minimize need to transport and dispose hazardous waste

Examples:
- Consider delisting listed hazardous waste if waste is not characteristically hazardous waste
- Segregate hazardous waste and non-hazardous waste

Date: 2/3/11

☐ Applicable
☐ Evaluated
☐ Practical

Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

This BMP is not applicable for this project. No hazardous waste is expected, and acid wash residual is neutralized and spread onsite.

BMP Category G: Waste Generation, Disposal, and Recycling

BMP G-5: When possible avoid/minimize use of hazardous/toxic materials that may require special handling or disposal Examples: - Cleaning solutions - Pesticides - Disposable batteries (use rechargeable batteries) - MMRP projects: minimize Chemical Agent Contaminated Medias (CACM) at RCWM sites	**Date:** 2/3/11 ☒ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☒ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *The project team is looking into a non-phosphate sequestering agent/dispersant (SK-2000 by Pristine Water Solutions). This would reduce the number of acid washes needed. The sequestering agent is not as hazardous as the acids used for the acid washes.*	

BMP G-6: Recycle or reuse materials rather than disposing of them Examples: - Cardboard - Plastics - Concrete - Asphalt - Steel and other metals - Recovered oil/product - Mulch/compost - MMRP projects – recycle recovered Material Documented as Safe (MDAS) after inspection and certification that the remnants are free of explosive hazards	**Date:** 2/3/11 ☒ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☒ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Cardboard packaging for well materials could be recycled. It should be determined if there is a local recycling center.*	

BMP Category H: Land Use, Ecosystems, and Cultural Resources

BMP H-1: Minimize erosion and soil transport to surface water bodies Examples: - Quickly restore any vegetated areas disrupted by equipment or vehicles - Institute appropriate erosion controls during excavation such as silt fencing	**Date:** 2/3/11 ☒ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☒ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *In the course of this linear construction project, stream areas will be watched carefully to ensure that soil erosion will not be a problem. It is believed that a soil erosion sediment control permit is not required other than for crossing state roads and the planned impoundments, but local requirements regarding soil erosion control should be looked into.*	

BMP H-2: Minimize disturbances to land Examples: - Establish well-defined traffic patterns for onsite activities to minimize disturbed areas - Consider non-intrusive investigation techniques (e.g., geophysical methods) to identify items like USTs and buried drums	**Date:** 2/3/11 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☒ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☒ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *USDA has required that project activities do not leave ruts or tear up vegetation. In addition, the treatment building is planned in an unutilized area, so it will not disturb land that is currently being used for other purposes.*	

BMP H-3: Preserve/restore ecosystems to the extent possible Examples: - Limit the removal of trees and vegetation - Attempt to transplant disturbed shrubs and small trees to other locations - Use native species for re-vegetation - Retrieve dead trees during excavation and later reposition them as habitat snags - Select and place suitably sized and typed stones into water beds and banks - Undercut surface water banks in ways that mirror natural conditions - Cut back rather than remove trees, bushes, vegetation	**Date:** 2/3/11 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☒ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☒ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *During construction, consider minimizing tree removal and other disturbances to the ecosystem. In addition, an effort should be made to use native plant species for re-vegetation (the project team will consult with the USDA on this matter during the appropriate remedial phase).*	

BMP H-4: Minimize drawdown of the water table in sensitive areas such as wetlands or areas subject to subsidence	**Date:** 2/3/11 ☒ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☒ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *There are wetland plants in the areas that would be inundated by the proposed reservoirs. In addition to the proposed impoundments creating new wetlands, the project team should look into other mitigating options. Since groundwater is ~100 ft below ground surface, there should be no issues with drawdown of groundwater in these wetland areas.*	

BMP H-5: Construct wells and other remedy infrastructure (piping, buildings, etc.) to minimize restrictions to anticipated future use of the site	**Date:** 2/3/11 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☒ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☒ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

The treatment building is planned on currently unused land, and all piping will be installed underground.

BMP H-6: Preserve/restore cultural resources to the extent possible Examples: - Protected lands such as wildlife refuges, national parks, and wilderness areas - Culturally sensitive sites such as cemeteries, native burials, and archaeological finds - Buildings or land parcels with historical significance	**Date:** 2/3/11 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☒ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☒ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

There is an old cemetery in the area, so the project team has planned the dam locations in a manner that will not cause the flooding of this cemetery.

BMP Category I: Safety and Community

BMP I-1: Minimize and mitigate noise, light and odor disturbance during all phases of the remedial process, to the extent practicable

Date: 2/3/11

☐ Applicable
☐ Evaluated
☐ Practical

Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Extraction well construction may go into the night if necessary, but due to the remoteness of the area (~3 miles to the nearest residence) noise disturbance should not be an issue. Similarly, the packed tower will not have a visual impact because of the distance from the nearest residence.

BMP I-2: Minimize dust during construction activities by spraying water or techniques such as laying biodegradable mats, tarps, or materials (already in EM385-1-1)

Date: 2/3/11

☒ Applicable
☒ Evaluated
☒ Practical

Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☒ Partially ☐ Not Yet ☐ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☐ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☒ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☒ Land-use

☒ BMP otherwise required?
If checked, required by:
EM385-1-1

Notes (including discussion of possible value of implementing the BMP):

Dust control is part of the standard project specifications. For treatment plant discharge, mats will be placed downstream to control erosion.

BMP Category I: Safety and Community

BMP I-3: Select transportation routes for trucks and heavy equipment that minimize impacts to residential areas to maximize safety and minimize noise and other aesthetic impacts	**Date:** 2/3/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

As there are only a few roads that provide access to the property, there are no real alternate transport routes. The existing routes do not impact residential areas.

BMP I-4: Minimize drawdown of the water table in areas that could impact production rates at supply wells and/or irrigation wells	**Date:** 2/3/11 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☒ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☒ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

The planned extraction wells comply with State requirements for well separation (minimum distance between wells). Since the aquifer is very transmissive, extraction should only cause a few feet of drawdown.

BMP I-5: Minimize amount of time that heavy machinery is needed to enhance safety	**Date:** 2/3/11 ☒ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☒ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

It is too early in the process for this BMP to be applied, but it should be considered prior to construction.

BMP I-6: Minimize handling of dangerous chemicals by selecting alternate chemicals and/or engineering to minimize contact with chemicals (for MMRP projects, there is enhanced risk related to explosion potential and exposure to chemical agents (CA) and agent breakdown products (ABP) associated with RCWM responses)	**Date:** 2/3/11 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☒ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☒ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

A non-phosphate dispersant will be used to minimize acid washing, which will reduce handling of chemicals.

BMP Category I: Safety and Community

BMP I-7: Contribute to local economy when possible Examples: - Consider leasing local office space - Purchase or lease equipment from local vendors - Hire workers from local community	**Date:** 2/3/11 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☒ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☒ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Project will use local construction contractors and treatment plant operators.

BMP Category J: Other Site-Specific BMPs

BMP J-1:			**Date:**
			☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A		
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000		
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use		☐ BMP otherwise required? If checked, required by:	
Notes (including discussion of possible value of implementing the BMP):			

BMP J-2:			**Date:**
			☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A		
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000		
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use		☐ BMP otherwise required? If checked, required by:	
Notes (including discussion of possible value of implementing the BMP):			

BMP Category J: Other Site-Specific BMPs

BMP J-3:	**Date:**
	☐ Applicable ☐ Evaluated ☐ Practical

Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

BMP J-4:	**Date:**
	☐ Applicable ☐ Evaluated ☐ Practical

Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

BMP Category J: Other Site-Specific BMPs

BMP J-5:	**Date:** ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP):	

BMP J-6:	**Date:** ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP):	

BMP Category J: Other Site-Specific BMPs

BMP J-7:		**Date:**
		☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A	
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000	
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:	
Notes (including discussion of possible value of implementing the BMP):		

BMP J-8:		**Date:**
		☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A	
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000	
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:	
Notes (including discussion of possible value of implementing the BMP):		

BMP Category J: Other Site-Specific BMPs

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☐ Evaluated
☐ Practical</td></tr>
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(discuss in notes if necessary):
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☐ Evaluated
☐ Practical</td></tr>
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(“N/A” if “Practical” not checked)
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(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A</td></tr>
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☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
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APPENDIX B

Supporting Information and/or Calculations for Quantitative Footprint Analysis of the Baseline Options

Appendix B
Assumptions for SiteWise Input and Other Calculations
Hastings Pilot GSR Evaluation
Baseline Option

Option 0 – Baseline P&T Remedy – SiteWise "Alternative 1" Directory

- 21 extraction wells pumping a 3,275 gpm
- One treatment plant with pumped discharge
- 30 years of operation

The notes pertaining to SiteWise input are organized by the following sections of SiteWise input:

- Extraction Well Installation – Uses "remedial Investigation" tab of SiteWise input for SiteWise "Alternative 1"

- Extraction and Influent Piping Installation - Uses "remedial action construction" tab of SiteWise input for "SiteWise "Alternative 1"

- Building Construction - Uses "remedial action operation" tab of SiteWise input for SiteWise "Alternative 1"

- O&M - Uses "longterm monitoring" tab of SiteWise input for "SiteWise "Alternative 1"

For each section of SiteWise, all the sections are listed, with pertinent information added only for those sections of the input sheet where data were added.

Other calculations done outside of SiteWise are then presented. These include the following:

- Hazardous Air Pollutants
- Refined Material Use
- Unrefined Material Use

A cost sheet is also attached. Some of the information on the cost sheet comes from Table 5 of the ROD (also attached). Information regarding the cost calculations is as follows:

- The capital cost of $19.8M comes from the Table 5 in the ROD, which is included in Appendix B. This includes the direct costs (e.g., extraction system, piping, treatment plant, etc.) of $13.5M, indirect costs (e.g., procurement, project management, contractor mobilization and demobilization, design plans, etc.) of $4.5M, and Owner's supervision and administration of $1.8M.

Baseline - Overview

- The annual cost of $1.344M is also taken from Table 5 of the ROD, for the first 30 years of the remedy (the active remedy period).

- Capital costs are assumed to occur in year 0, and annual costs are assumed to occur in years 1 to 30.

- To determine net present value (NPV), a 3 percent discount rate is applied to future costs, which is consistent with the discount rate applied in the ROD.

- NPV is calculated by discounting future costs to present-day dollars using the following equation:

$$PV = \frac{FV}{(1+i)^n} = C \times FV$$

PV is the present value
FV is the value in year "n" (i.e., future value)
i is the discount rate
C is the discount factor, which equals $1/(1+i)^n$

Baseline – Extraction Well Installation

Scope of Work

- Drilling
    - 11 extraction wells, average depth of 140 ft each, 8 inch diameter, steel casing
    - 9 extraction wells, average depth of 140 ft each, 10 inch diameter, steel casing
    - 14 of the above wells are for the NE System and 6 are for the SE System
    - 6 pump houses
    - Wells installed by mud rotary drilling
    - 8 hrs of drilling per location (20 days of drilling) with a three-person crew
    - 20 additional days for pump installation and hook-up equipment use
    - Drilling cuttings and mud spread on ground near drilling locations
    - Assume steel casing comes from 500 miles away
    - Assume cement comes from 50 miles away

- Well development
    - 5 more days for well development
    - 5 days of 8-hours per day of operating a generator at 5HP
    - Well development = 1200 gal/well (assumes 30 ft saturated thickness, 8 to 10 inch diameter, and 10+ casing volumes)

- Transportation
    - Driller
        - Drill rig 25 miles one-way distance, four trips to site (one trip per week for 4 weeks)
        - Heavy support truck 25 miles one-way distance, four trips to site (one trip per week for 4 weeks)
        - Light duty vehicle 25 miles one-way distance, 45 trips to site with 3 individuals for drilling, pump installation, and well development
    - Consultant oversight
        - 300 miles one-way distance, five trips to site (~ one trip per week for one person, for 9 weeks)
        - Daily (45 trips total) to and from hotel (assume 20 miles one way)

Baseline – Extraction Well Installation

<u>SiteWise Input – Input into "Remedial Investigation" tab of SiteWise "Alternative 1"</u>

- Material Production
    - Well Materials
        - Well Type 1 – 10-inch wells
        - Well Type 2 – 8-inch wells
    - Treatment Chemicals & Materials
    - GAC
    - Construction materials
    - Well decommissioning – chosen to represent grout use for well installation
        - Well Type 1 – 10 inch wells
        - Well Type 2 – 8-inch wells

- Transportation
    - Personnel Transportation – Road
        - Trip 1 – Round-trip for light truck supporting drill rig (daily trips)
        - Trip 2 – Round-trip for drill rig (weekly trips)
        - Trip 3 – Round-trip for heavy duty truck supporting drill rig (weekly trips)
        - Trip 4 – Round-trips for consultant from Lenexa, KS (weekly trips)
        - Trip 5 – Round-trips for consultant to and from hotel (daily trips)
    - Personnel Transportation – Air
    - Personnel Transportation – Rail
    - Equipment Transportation – Road
        - assume round-trip mileage to account for empty return trip
        - Trip 1 – Mileage and tonnage for transporting steel for extraction wells. Calculate mileage by accounting for delivery trip and empty return trip from a distance of 500 miles (1,000 miles roundtrip). Calculate tonnage by taking weight of steel in pounds from Material Production tab of Remedial Investigation sheet, dividing by 2000 pounds per ton, and dividing by 2 to provide an average of the tonnage for the delivery trip and empty return trip.
        - Trip 2 – Mileage and tonnage for transporting cement grout for extraction wells. Calculate mileage by accounting for delivery trip and empty return trip from a distance of 500 miles (1,000 miles roundtrip) and multiply by 4 total trips. Calculate tonnage by taking weight of grout in pounds from Material Production tab of Remedial Investigation sheet, dividing by 2000 pounds per ton, dividing by 4 trips, and dividing by 2 to provide an average of the tonnage for the delivery trip and empty return trip.
    - Equipment Transportation – Air
    - Equipment Transportation – Rail
    - Equipment Transportation – Water

- Equipment Use
    - Earthwork
    - Drilling
        - Event 1 – 10-inch wells
        - Event 2 – 8-inch wells
    - Pump operation

  - Diesel and Gasoline Pumps
  - Blower, Compressor, Mixer, and Other Equipment
  - Generators
    - Generator 1 – operate well development pumps
  - Agricultural Equipment
  - Capping Equipment
  - Mixing Equipment

- Residual Handling
  - Residue Disposal/Recycling
  - Landfill Operations
  - Thermal/Catalytic Oxidizers
  - Water Consumption
  - Landfill Methane Emissions

- Other Known On-Site Activities
  - Water from redevelopment not specified because development water is assumed to be discharged to surface

Baseline – Extraction and Effluent Piping Installation

<u>Scope of Work</u>

- Install piping following piping lengths measured from drawings
- Trench volume is calculated for “earthwork” portion of input for excavator use, which requires cubic yards for input. The trench volume is calculated as length multiplied by x-section area, then divide by 27 to convert from cubic feet to cubic yards.
- For construction materials portion of input, SiteWise only has HDPE in units of volume, not length of pipe. Therefore, need to calculate HDPE mass and use density of 0.946 g/cc = 58.9 lbs/cf to calculate volume of HDPE for input.

    - NE system

Size	Length (ft)	HDPE (lbs/ft)	Trench X-Sect. Area (ft2)	Trench Volume (cy)	HDPE Mass (lbs)
6-inch	5,000	5	10	1,851	25,000
8-inch	13,000	8.4	10	4,815	109,200
12-inch	1,400	18.4	10	519	25,760
16-inch	2,600	29.0	15	1,444	75,400
20-inch	2,600	45.3	18	1,733	117,780
22-inch	1,800	54.8	18	1,200	98,640
Total	26,400			11,562	451,780
					7,670 ft3

    *Mass = 451,780 lbs * 1cf/58.9 lbs = 7,670 cf for volume of HDPE*

    - SE system

Size	Length (ft)	HDPE (lbs/ft)	Trench X-Sect. Area (ft2)	Trench Volume (cy)	HDPE Mass (lbs)
6-inch	4,600	5	10	1,704	23,000
8-inch	7,000	8.4	10	2,593	58,800
12-inch	6,400	18.4	10	2,370	117,760
14-inch	18,600	22.2	15	10,333	412,920
Total	36,600		**Total**	17,000	612,480
					10,399 ft3

    *Mass = 612,480 lbs * 1cf/58.9 lbs = 10,399 cf for volume of HDPE*

    - Effluent piping
        - 3000 feet of 22-inch pipe
            - 2,000 cy for trench
            - 164,400 lbs of HDPE * *1cf/58.9 lbs* = 2,791 cf

- Bedding and back fill with native fill
- Excavation and backfill assumed to be done by hydraulic excavator. Number of crew days for work is assumed to be approximately equal to the total hours of equipment operation calculated by SiteWise divided by 8 hours per day. Crew is assumed to be two individuals.
- Productivity rate for laying pipe is assumed to be approximately 250 feet per day for a crew of 4.

Baseline – Extraction and Effluent Piping Installation

- Equipment – assume one trip to site for the following equipment
    - 4 excavators
    - 4 loaders
    - Heat fusers and equipment for lifting and pulling pipe is excluded

- Oversight consultant (2 individuals riding together in a light duty truck)
    - 300 miles one-way distance, one trip per week (12 weeks = 12 trips)
    - Daily trips (60 trips) to and from hotel, 20 miles each way

- HDPE SDR 11 pipe transported from 500 miles from site (assumed generic distance)

Baseline – Extraction and Effluent Piping Installation

<u>SiteWise Input – Input into "Remedial Action Construction" tab of SiteWise "Alternative 1"</u>

- Material Production
    - Well Materials
    - Treatment Chemicals & Materials
    - GAC
    - Construction Materials
        - Material 1 – HDPE for NE system piping
        - Material 2 – HDPE for SE system piping
        - Material 3 – HPDE for Effluent piping
    - Well Decommissioning

- Transportation
    - Personnel Transportation – Road
        - Trip 1 – Round-trips for pipe-laying crew calculated by taking 66,000 feet of piping and dividing by productivity rate of 250 feet per day.
        - Trip 2 – Round-trips for excavation and backfill crew calculated by taking total number of equipment operation hours from SiteWise and dividing by 8 hours per day and rounding result as appropriate
        - Trip 3 – Round-trips for heavy equipment (one round-trip per piece of equipment and two pieces of equipment for each extraction system)
        - Trip 4 – Round-trips for consultant from Lenexa, KS on a weekly basis. Assumes contractor work is accomplished by two parallel crews and that total work takes 60 days resulting in 12 weekly trips.
        - Trip 5 –Round-trips for consultant to and from hotel on a daily basis for 60 days.
    - Personnel Transportation – Air
    - Personnel Transportation – Rail
    - Equipment Transportation – Road
        - assume round-trip mileage to account for empty return trip
        - Trip 1 – Mileage and tonnage for transporting HDPE for NE System. Assumes distance of 500 miles for shipping, plus an empty return trip for a total of 1,000 miles per trip. Number of trips is determined based on hauling approximately 20 tons per load. Reported mileage is the number of trips multiplied by 1,000 miles per trip. Tonnage is equal to the total weight hauled, divided by the number of trips (for approximately 20 tons), divided by 2 to provide an average of the tonnage for the delivery trip and empty return trip.
        - Trip 2 – HDPE for SE System piping using same data entry assumptions as used for NE System
        - Trip 3 – HDPE for effluent piping using same data entry assumptions as used for NE System
    - Equipment Transportation – Air
    - Equipment Transportation – Rail
    - Equipment Transportation – Water

- Equipment Use – Equipment use is a hydraulic excavator for excavation and backfill of the trench. SiteWise determines the equipment horsepower and bucket size based on total cubic yards excavated. Although this may be appropriate for single, large excavation, it is not necessarily appropriate for trenching. In addition, the productivity rates provided in SiteWise for excavator use do not agree with those provided by RS Means construction data. The Look Up Table in SiteWise Input Sheet.xls was modified to provide a consistent and appropriate equipment size for all trenching. Productivity rates were also updated to be consistent with RS Means construction data.

  - Earthwork
    - Equipment 1 – Excavator for NE trenching
    - Equipment 2 – Excavator for NE backfill
    - Equipment 3 – Excavator for NE trenching
    - Equipment 4 – Excavator for NE backfill
    - Equipment 5 – Excavator for effluent piping
    - Equipment 6 – Excavator for effluent piping
    -
  - Drilling
  - Pump operation
  - Diesel and Gasoline Pumps
  - Blower, Compressor, Mixer, and Other Equipment
  - Generators
  - Agricultural Equipment
  - Capping Equipment
  - Mixing Equipment

- Residual Handling
  - Residue Disposal/Recycling
  - Landfill Operations
  - Thermal/Catalytic Oxidizers
  - Water Consumption
  - Landfill Methane Emissions

- Other Known On-Site Activities

Baseline – Building Construction

Scope of Work

- 100 ft x 80 ft, 34 feet tall (Section 4.2.1.3 of the 30% design)
- 100 ft x 80 ft x 0.5 ft concrete slab = 4000 cubic feet (Section 4.2.1.3 of the 30% design)
- 100 ft x 80 ft, 40 mil HDPE vapor barrier = 27 cubic feet of HDPE (Section 4.2.1.3 of the 30% design specifies a vapor barrier, engineering estimate to assume 40 mil HDPE)
- Reinforcing steel, placed 6-inches on center with #4 rebar, 0.668 lbs/ft = 21,376 lbs (engineering estimate)
- Buildings steel is 32,000 lbs of steel based on approximately 4 lbs per square foot for building with 30-foot eave height (engineering estimate)
- 100 ft x 80 ft x 0.5 ft gravel base layer = 4000 cubic feet (engineering estimate)
- Concrete transported from 50 miles away (generic assumption)
- Steel transported from 500 miles away (generic assumption)
- Contractor 40 days (4 people in two light duty trucks from 25 miles away, engineering estimate)
- Crane operation excluded
- Oversight 40 days
    - 300 miles one-way distance, one trip per week (4 weeks = 4 trips)
    - 4 trips per week (16 trips total) to and from hotel (assume 20 miles one way)

Baseline – Building Construction

<u>SiteWise Input – Input into "Remedial Action Operation" tab of SiteWise "Alternative 1"</u>

- Material Production
    - Well Materials
        - Well Type 1 – Modified to reflect steel usage for rebar (i.e., input a value for depth of wells of 274 ft determined so that output weight of steel on "remedial action operations" output spreadsheet in SiteWise Alternative 1 reflects the estimated weight of rebar, which is 21,376 lbs)
        - Well Type 2 – Modified to reflect steel usage for building (i.e., input a value for depth of wells of 274 ft determined so that output weight of steel on "remedial action operations" output spreadsheet in SiteWise Alternative 1 reflects the estimated weight of building steel, which is 32,000 lbs)
    - Treatment Chemicals & Materials
    - GAC
    - Construction Materials
        - Material 1 – HDPE for vapor barrier (modified to reflect 27 ft3)
        - Material 2 – Concrete for foundation
        - Material 3 – Gravel for foundation base
    - Well Decommissioning

- Transportation
    - Personnel Transportation – Road
        - Trip 1 – 80 round-trips for (two crews for 40 days), two people each crew
        - Trip 2 – 8 round-trips for consultant from Lenexa, KS (weekly trips)
        - Trip 3 – 40 round-trips for consultant to and from hotel (daily trips)
    - Personnel Transportation – Air
    - Personnel Transportation – Rail
    - Equipment Transportation – Road
        - Trip 1 – Mileage and tonnage for transporting steel. Assumes distance of 500 miles for shipping, plus an empty return trip for a total of 1,000 miles per trip. One trip for buildings steel and one trip for rebar are assumed. Reported mileage is the number of trips multiplied by 1,000 miles per trip. Tonnage is equal to the total weight hauled, divided by the number of trips, divided by 2 to provide an average of the tonnage for the delivery trip and empty return trip.
        - Trip 2 – Mileage and tonnage for transporting concrete. Assumes distance of 50 miles for transport, plus an empty return trip for a total of 100 miles per trip. Number of trips is determined based on hauling approximately 20 tons per load. Reported mileage is the number of trips multiplied by 100 miles per trip. Tonnage is equal to the total weight hauled, divided by the number of trips (for approximately 20 tons), divided by 2 to provide an average of the tonnage for the delivery trip and empty return trip.
        - Trip 3 – HDPE for vapor barrier from 1000 miles round-trip (includes empty return trip).
        - Trip 4 – Gravel for foundation base. Data entry assumptions are the same as those for concrete.
    - Equipment Transportation – Air
    - Equipment Transportation – Rail
    - Equipment Transportation – Water

Baseline – Building Construction

- Equipment Use
  - Earthwork
  - Drilling
  - Pump operation
  - Diesel and Gasoline Pumps
  - Blower, Compressor, Mixer, and Other Equipment
  - Generators
  - Agricultural Equipment
  - Capping Equipment
  - Mixing Equipment

- Residual Handling
  - Residue Disposal/Recycling
  - Landfill Operations
  - Thermal/Catalytic Oxidizers
  - Water Consumption
  - Landfill Methane Emissions

- Other Known On-Site Activities

Baseline – System O&M

Scope of Work

- Extraction pumps (use method 2 in SiteWise)
  - NE System - 110 feet of static head + 0 feet of average change in elevation +30 feet to top of air stripper + 15 feet of friction loss
  - SE System – 110 feet of static head + 20 feet of average change in elevation + 30 feet to top of air stripper + 45 feet of friction loss
  - Average flow rate of 3275 gpm
    - NE System – 2275 gpm from 15 wells
    - SE System – 1000 gpm from 6 wells
  - Various pumping schemes will require various pumping rates and various total dynamic heads (due to variation in friction losses) throughout the course of the remedy. Maximum flow rates are different for different wells. For simplicity, it is assumed that each well is outfitted with a 15 HP pump similar to the Grundfos 230S-150-5B, which is rates for 200 gpm at 220 feet of total dynamic head. The motor efficiency for this pump is approximately 81%
  - Assume pumps operate for 30 yrs = 262,800 hrs.
- Blowers for air strippers two 20HP blowers
- Effluent pump – assume no change in elevation, and 5 feet of head loss through pipe.
- Operator travel –
  - weekly visits for 30 years (1560 visits) from 20 miles away,
  - quarterly travel for 30 years (120 visits) from 300 miles away
- Assume electricity generation is consistent with eGRID subregion provided in SiteWise

Baseline – System O&M

<u>SiteWise Input – Input into “Longterm Monitoring” tab in SiteWise “Alternative 1”</u>

- Material Production
    - Well Materials
    - Treatment Chemicals & Materials
    - GAC
    - Construction Materials
    - Well Decommissioning

- Transportation
    - Personnel Transportation – Road
        - Trip 1 – weekly operator checks
        - Trip 2 – quarterly engineering inspections/checks
    - Personnel Transportation – Air
    - Personnel Transportation – Rail
    - Equipment Transportation – Road
    - Equipment Transportation – Air
    - Equipment Transportation – Rail
    - Equipment Transportation – Water

- Equipment Use
    - Earthwork
    - Drilling
    - Pump operation (use method 3)
        - Pump 1 – NE system extraction pumps, default pump load assumed
        - Pump 2 – SE system extraction pumps, default pump load assumed
        - Pump 3 – Effluent pump
    - Diesel and Gasoline Pumps
    - Blower, Compressor, Mixer, and Other Equipment
        - Use method 1
        - Equipment 1 – Blower 1
        - Equipment 2 – Blower 2
    - Generators
    - Agricultural Equipment
    - Capping Equipment
    - Mixing Equipment

- Residual Handling
    - Residue Disposal/Recycling
    - Landfill Operations
    - Thermal/Catalytic Oxidizers
    - Water Consumption
        - Assumptions:

            - Need to add remedy pumping to the water use calculated by SiteWise (for electricity use from the blowers and pumps). In summary tab of the LongTerm Monitoring.xls sheet, the total water use will be the pumping amount plus the water use due to pump electricity plus the water use due to blower electricity

- Assume appreciable water use for remedy pumping is all extracted and treated that is discharged to surface water. This may be an overestimate because some infiltration of treated water will occur, this calculation assumes no infiltration .

$$3{,}275\,\frac{gal}{min} \times 1{,}440\,\frac{min}{day} \times 365\,\frac{days}{yr} \times 30yrs = 51{,}640{,}200{,}000 \text{ gallons}$$

  - Landfill Methane Emissions

- Other Known On-Site Activities

Other Supporting Calculations
Hastings Pilot GSR Evaluation
Baseline Option

Option 0 - Baseline P&T Remedy

Hazardous Air Pollutant Emissions

Assumptions:

- All hazardous air pollutants for project are emitted from air stripper off-gas. Hazardous air pollutants from electricity generation and materials manufacturing are also present but not calculated by SiteWise.
- Average influent concentration over 30-year period is 12.5 ug/L TCE (50% of design influent concentration of 25 ug/L TCE).
- Average extraction rate over 30-year period is 3,275 gpm
- Complete removal of TCE by air strippers

$12.5\,\frac{\mu g}{L} \times 3{,}275\,\frac{gal}{min} \times 3.785\,\frac{L}{gal} \times 1{,}440\,\frac{min}{day} \times 365\,\frac{days}{yr} \times 30yrs \times 10^{-9}\,\frac{kg}{\mu g} \times 2.2\,\frac{lbs}{kg}$=5,375 lbs TCE

Refined Materials Use

Assumptions:

- Includes the following refined materials as the primary refined materials involved in the project:
  - HPDE for piping and vapor barrier
  - Steel for extraction wells, building, and building foundation
  - 50% of concrete used for building foundation (the other 50% is assumed to be aggregate, which is considered an unrefined material)
  - Cement grout used for extraction wells

- Other refined materials assumed to have negligible contribution to total materials use

HDPE for NE system	451,780 lbs
HDPE for SE system	612,480 lbs
Steel for extraction wells (from SiteWise)	19,778 lbs
Steel for building	32,000 lbs
Steel for foundation	21,376 lbs
50% of concrete (from SiteWise)	584,214 lbs
Cement grout (from SiteWise)	150,365 lbs
HDPE for vapor barrier	1605 lbs
Total	**1,873,598 lbs**

Unless otherwise noted, the quantities of the above materials are obtained from the above notes.

Unrefined Materials Use

Assumptions:

- Includes the following unrefined materials as the primary unrefined materials involved in the project:
  - 50% of concrete used for building foundation (the other 50% is assumed to be cement, which is considered a refined material)
  - Gravel for building foundation base

- Other refined materials assumed to have negligible contribution to total materials use

50% of concrete (from SiteWise)		292 tons
Gravel		207 tons
	Total	**499 tons**

Unless otherwise noted, the quantities of the above materials are obtained from the above notes.

One-Way Heavy Vehicle Trips through Residential Area

Estimated 72 trips based on equipment/materials transport identified earlier.

Table 5
Cost Estimated Summary for the Selected Remedy (Alternative 3)

Capital Costs – Direct		
Extraction System	$4,080,000	
Piping to Treatment Systems	$4,775,000	
Treatment Systems and Related Infrastructure	$1,755,000	
Effluent Piping/Discharge	$1,387,000	
Groundwater Monitoring Wells	$1,508,000	
Subtotal		***$13,505,000***
Capital Costs – Indirect		
Procurement, Construction Services, Project Management	$2,026,000	
Contractor Mob/Demob/Profit	$1,351,000	
Design, Plans, Specifications, Record Drawings	$1,080,000	
Subtotal		***$4,457,000***
Owner's Supervision and Administration		**$1,796,000**
Total Estimated Capital Costs		***$19,800,000****

Annual Costs – Direct (Years 1 through 30)		**Present Worth (3%)**
Maintenance, Repair, Replacement	$940,000	
• Extraction System		
• Piping to Treatment System		
• Effluent Piping/Discharge		
• Groundwater Monitoring Wells		
Annual Costs – Indirect (Years 1 through 30)	$282,000	
Owner's Supervision and Administration (Years 1 through 30)	$122,000	
Total Estimated Annual Costs (Years 1 through 30)	**$1,344,000**	**$27,306,000**
Total Estimated Annual Costs (Years 31 through 50)	**$331,000**	**$2,305,000**
Total Estimated Costs Every 5 Years (Years 51 through 95)	**$225,000**	**$392,000**
Total Present Worth Annual and Periodic Costs		**$30,000,000***
Total Present Worth Costs		**$49,800,000***

Note(s):

**Rounded to the nearest $100,000. All other are rounded to the nearest $1,000.*

The information in this cost estimate summary table is based on the best available information regarding the anticipated scope of the remedial alternative. This is an order-of-magnitude engineering cost estimate and changes are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative.

Additional cost details can be found in Appendix B of the Feasibility Study Addendum.

Project: GSR Pilot for Former NAD - Hastings
Option or Alternative: Baseline Option
Current Date: 2/5/2011

year	up-front cost	annual cost		present value of cost each year		cumulative cash flow	
		(no discounting)		3%		no discounting	3%
0	$19,800,000	$0		$19,800,000		$19,800,000	$19,800,000
1	$0	$1,344,000		$1,304,854		$21,144,000	$21,104,854
2	$0	$1,344,000		$1,266,849		$22,488,000	$22,371,703
3	$0	$1,344,000		$1,229,950		$23,832,000	$23,601,654
4	$0	$1,344,000		$1,194,127		$25,176,000	$24,795,780
5	$0	$1,344,000		$1,159,346		$26,520,000	$25,955,126
6	$0	$1,344,000		$1,125,579		$27,864,000	$27,080,705
7	$0	$1,344,000		$1,092,795		$29,208,000	$28,173,500
8	$0	$1,344,000		$1,060,966		$30,552,000	$29,234,466
9	$0	$1,344,000		$1,030,064		$31,896,000	$30,264,530
10	$0	$1,344,000		$1,000,062		$33,240,000	$31,264,593
11	$0	$1,344,000		$970,934		$34,584,000	$32,235,527
12	$0	$1,344,000		$942,655		$35,928,000	$33,178,181
13	$0	$1,344,000		$915,199		$37,272,000	$34,093,380
14	$0	$1,344,000		$888,542		$38,616,000	$34,981,922
15	$0	$1,344,000		$862,662		$39,960,000	$35,844,585
16	$0	$1,344,000		$837,536		$41,304,000	$36,682,121
17	$0	$1,344,000		$813,142		$42,648,000	$37,495,263
18	$0	$1,344,000		$789,458		$43,992,000	$38,284,722
19	$0	$1,344,000		$766,464		$45,336,000	$39,051,186
20	$0	$1,344,000		$744,140		$46,680,000	$39,795,326
21	$0	$1,344,000		$722,466		$48,024,000	$40,517,792
22	$0	$1,344,000		$701,424		$49,368,000	$41,219,216
23	$0	$1,344,000		$680,994		$50,712,000	$41,900,210
24	$0	$1,344,000		$661,159		$52,056,000	$42,561,369
25	$0	$1,344,000		$641,902		$53,400,000	$43,203,270
26	$0	$1,344,000		$623,206		$54,744,000	$43,826,476
27	$0	$1,344,000		$605,054		$56,088,000	$44,431,530
28	$0	$1,344,000		$587,431		$57,432,000	$45,018,961
29	$0	$1,344,000		$570,322		$58,776,000	$45,589,283
30	$0	$1,344,000		$553,710		$60,120,000	$46,142,993

Net Present Value (NPV)-> $46,142,993

*positive dollar value is a "cost", negative dollar value is a "savings"

GSR Team Calculations to Split Energy Results from SiteWise into "Direct" and "Indirect"
Baseline P&T Remedy

phase	Reported by SiteWise: activity	Reported by SiteWise: energy used (MMBTU)	Assigned by GSR Team from SiteWise Output: Scope 1 (direct) energy used (MMBTU)	Assigned by GSR Team from SiteWise Output: Scope 2 (indirect) energy used (MMBTU)	Assigned by GSR Team from SiteWise Output: Scope 3 (indirect) energy used (MMBTU)	Added by GSR Team: Scope 3 (indirect) energy used (MMBTU)	Total Calculated by GSR Team
Extraction Well Installation (remedial investigation tab)	Consumables	547.56	0.00	0.00	547.56	0.00	547.56
	Transportation-Personnel	85.07	0.00	0.00	85.07	20.42	105.49
	Transportation-Equipment	97.64	0.00	0.00	97.64	23.43	121.07
	Equipment Use and Misc	330.27	330.27	0.00	0.00	79.26	409.54
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-Total	1060.54	330.27	0.00	730.27	123.12	1183.66
Extraction and Influent Piping Installation (remedial action construction tab)	Consumables	55495.28	0.00	0.00	55495.28	0.00	55495.28
	Transportation-Personnel	230.43	0.00	0.00	230.43	55.30	285.74
	Transportation-Equipment	622.99	0.00	0.00	622.99	149.52	772.50
	Equipment Use and Misc	1749.50	1749.50	0.00	0.00	419.88	2169.38
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-Total	58098.20	1749.50	0.00	56348.70	624.70	58722.90
Building Construction (remedial action operation tab)	Consumables	1154.46	0.00	0.00	1154.46	0.00	1154.46
	Transportation-Personnel	85.97	0.00	0.00	85.97	20.63	106.61
	Transportation-Equipment	105.97	0.00	0.00	105.97	25.43	131.40
	Equipment Use and Misc	0.00	0.00	0.00	0.00	0.00	0.00
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-Total	1346.41	0.00	0.00	1346.41	46.07	1392.47
O&M (longterm monitoring tab)	Consumables	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	887.84	0.00	0.00	887.84	213.08	1100.92
	Transportation-Equipment	0.00	0.00	0.00	0.00	0.00	0.00
	Equipment Use and Misc	767290.51	253205.87	514084.64	0.00	0.00	767290.51
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-Total	768178.35	253205.87	514084.64	887.84	213.08	768391.43
total		828683.50	255285.64	514084.64	59313.22	1006.96	829690.46

Note: *For energy use related to fuel use for transportation or on-site equipment use, SiteWise reports energy use associated with combustion only. The added Scope 3 energy use for these activities take into account upstream energy use (i.e. energy required for extraction, refining, etc.). The added energy is based on multipliers used in the GREET software, version 1.8d.1, which in this case equates to multiplying energy used in fuel combustion by 0.24 to calculate the upstream energy use.*

Electricity use reported by SiteWise in units of kWh is "Direct Scope 1", meaning it is energy consumed at the location of the project. However, energy use associated with electricity reported by SiteWise in units of MMBtu is a life-cycle value which also includes a factor to account for energy used elsewhere required to generate the electricity ("Indirect Scope 2"). Here, 33% of the life-cycle value reported by SiteWise is considered to be "Scope 1" on-site energy use, and 67% is considered to be "Scope 2" energy used in electricity generation.

GSR Team Calculations to Split GHG Results from SiteWise into "Direct" and "Indirect"
Baseline P&T Remedy

phase	Reported by SiteWise: activity	Reported by SiteWise: GHG emitted (metric tons CO2e)	Assigned by GSR Team from SiteWise Output: Scope 1 (direct) GHG emitted (metric tons CO2e)	Assigned by GSR Team from SiteWise Output: Scope 2 (indirect) GHG emitted (metric tons CO2e)	Assigned by GSR Team from SiteWise Output: Scope 3 (indirect) GHG emitted (metric tons CO2e)	Added by GSR Team: Scope 3 (indirect) GHG emitted (metric tons CO2e)	Total Calculated by GSR Team
Extraction Well Installation (remedial investigation tab)	Consumables	75.99	0.00	0.00	75.99	0.00	75.99
	Transportation-Personnel	7.62	0.00	0.00	7.62	1.83	9.45
	Transportation-Equipment	6.67	0.00	0.00	6.67	1.602	8.28
	Equipment Use and Misc	23.53	23.53	0.00	0.00	5.65	29.18
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-Total	113.81	23.53	0.00	90.29	9.08	122.89
Extraction and Influent Piping Installation (remedial action construction tab)	Consumables	1465.46	0.00	0.00	1465.46	0.00	1465.46
	Transportation-Personnel	21.08	0.00	0.00	21.08	5.06	26.14
	Transportation-Equipment	42.58	0.00	0.00	42.58	10.22	52.80
	Equipment Use and Misc	106.94	106.94	0.00	0.00	25.67	132.61
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-Total	1636.06	106.94	0.00	1529.11	40.94	1677.00
Building Construction (remedial action operation tab)	Consumables	105.41	0.00	0.00	105.41	0.00	105.41
	Transportation-Personnel	7.86	0.00	0.00	7.86	1.89	9.75
	Transportation-Equipment	7.24	0.00	0.00	7.24	1.74	8.98
	Equipment Use and Misc	0.00	0.00	0.00	0.00	0.00	0.00
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-Total	120.52	0.00	0.00	120.52	3.62	124.14
O&M (longterm monitoring tab)	Consumables	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	81.44	0.00	0.00	81.44	19.55	100.99
	Transportation-Equipment	0.00	0.00	0.00	0.00	0.00	0.00
	Equipment Use and Misc	66356.68	0.00	66356.68	0.00	0.00	66356.68
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-Total	66438.13	0.00	66356.68	81.44	19.55	66457.67
total		68308.51	130.47	66356.68	1821.36	73.19	68381.70

Note: For GHG emissions related to fuel use for transportation or on-site equipment use, SiteWise reports emissions associated with combustion only. The added Scope 3 emissions for these activities take into account upstream emissions (i.e. emissions related to extraction, refining, etc.). The added emissions factor is based on multipliers used in the GREET software, version 1.8d.1, which in this case equates to multiplying emission from fuel combustion by 0.24 to calculate the upstream emissions.

CO2e reported by SiteWise for electricity use is all associated with generation of the electricity ("Indirect Scope 2").

APPENDIX C

Supporting Information and/or Calculations for Footprint Impacts of Selected Design Alternatives

APPENDIX C-1

Power the Remedy with Wind Energy

Appendix C1
Assumptions for SiteWise Input and Other Calculations
Hastings Pilot GSR Evaluation

Power The Remedy With Wind Energy

This option involves the use of on-site wind turbines to provide all of the approximately 73,800 MWh of the electricity estimated to be used by the remedy Baseline Option for O&M (pumps and blowers). It is assumed that the use of wind energy would involve no emissions of CO2e, NOx, SOx, PM, or HAPs and would not involve the use of water. Wind energy does not conserve electricity, but it uses energy from renewable resources and improves the GSR parameter for percentage of energy from renewable resources. Footprint for constructing the wind turbines is not considered.

The following table includes the CO2e, NOx, SOx, and water footprints associated with all electricity use that SiteWise calculated for the Baseline Option for O&M (over 30 years of active O&M). This is reported in the SiteWise Alternative 1 directory, LongTerm Monitoring.xls sheet (which was used for the Baseline Option O&M calculations). The values reported below for the pumps are reported on the "equipment use - pumps" tab, and the values reported below for the blowers are reported on the "equipment use – electrical" tab. The footprint for the baseline P&T system would be reduced by these amounts.

	Value Offset by Using Wind Power				
SiteWise Component	**Energy* (MMBtu)**	**CO2e (m. tons)**	**NOx (m. tons)**	**SOx (m. tons)**	**Water (gallons)**
Electric Pump Operation	690,000	59,000	120	200	34,000,000
Electric Blower Operation	81,000	7,000	14	24	4,000,000
Total (MMBtu, m. tons & gallons)	771,000	66,000	134	224	38,000,000
Total (MMBtu, lbs & gallons)	771,000	145,200,000	294,800	492,800	38,000,000

** Energy is not offset. Rather, this is the amount of energy that would be from renewable resources.*

SiteWise does not calculate the PM or HAPs associated with electricity generation; therefore, information for those footprints are not included in the table.

A cost spreadsheet is also attached. At this point the GSR team has no way to estimate the capital costs of the Wind project. An estimate of $2M is entered in the cost sheet only to illustrate the concept of payback period. Annual cost savings are estimated based on a current electricity rate of $0.0658 per kWh is average retail price for electricity in Nebraska according to www.eia.gov on 2/3/11. The annual electrical savings are calculated below based on the SiteWise output for kWh for the Baseline Option (over 30 years) that are reported the following kWh (same tabs as described above) ,divided by 30 to get an annual result:

- Pumps: 66,000,000 kWh x $0.0658/kWh / 30 = $144,760
- Blowers: 7,800,000 kwH x $0.0658/kWh / 30 = $ 17,108

Total annual savings is thus estimated at $162,000 per year, which is entered into the cost sheet. For the "fictitious" capital cost of $2M entered in the sheet, payback would occur in approximately 13 years with no discounting, or 16 years with discounting. The payback period would be higher or lower depending on the actual value for capital costs.

Project: GSR Pilot for Former NAD - Hastings
Option or Alternative: Changes due to Alternative 1: Power the remedy with wind energy
Current Date: 2/5/2011

year	up-front cost	annual cost	present value of cost each year	cumulative cash flow	
		(no discounting)	3%	no discounting	3%
0	$2,000,000	$0	$2,000,000	$2,000,000	$2,000,000
1	$0	-$162,000	-$157,282	$1,838,000	$1,842,718
2	$0	-$162,000	-$152,701	$1,676,000	$1,690,018
3	$0	-$162,000	-$148,253	$1,514,000	$1,541,765
4	$0	-$162,000	-$143,935	$1,352,000	$1,397,830
5	$0	-$162,000	-$139,743	$1,190,000	$1,258,087
6	$0	-$162,000	-$135,672	$1,028,000	$1,122,415
7	$0	-$162,000	-$131,721	$866,000	$990,694
8	$0	-$162,000	-$127,884	$704,000	$862,810
9	$0	-$162,000	-$124,160	$542,000	$738,650
10	$0	-$162,000	-$120,543	$380,000	$618,107
11	$0	-$162,000	-$117,032	$218,000	$501,075
12	$0	-$162,000	-$113,624	$56,000	$387,451
13	$0	-$162,000	-$110,314	-$106,000	$277,137
14	$0	-$162,000	-$107,101	-$268,000	$170,036
15	$0	-$162,000	-$103,982	-$430,000	$66,055
16	$0	-$162,000	-$100,953	-$592,000	-$34,899
17	$0	-$162,000	-$98,013	-$754,000	-$132,911
18	$0	-$162,000	-$95,158	-$916,000	-$228,069
19	$0	-$162,000	-$92,386	-$1,078,000	-$320,455
20	$0	-$162,000	-$89,695	-$1,240,000	-$410,151
21	$0	-$162,000	-$87,083	-$1,402,000	-$497,234
22	$0	-$162,000	-$84,547	-$1,564,000	-$581,780
23	$0	-$162,000	-$82,084	-$1,726,000	-$663,865
24	$0	-$162,000	-$79,693	-$1,888,000	-$743,558
25	$0	-$162,000	-$77,372	-$2,050,000	-$820,930
26	$0	-$162,000	-$75,119	-$2,212,000	-$896,048
27	$0	-$162,000	-$72,931	-$2,374,000	-$968,979
28	$0	-$162,000	-$70,806	-$2,536,000	-$1,039,786
29	$0	-$162,000	-$68,744	-$2,698,000	-$1,108,530
30	$0	-$162,000	-$66,742	-$2,860,000	-$1,175,271

Net Present Value (NPV)-> -$1,175,271

*positive dollar value is a "cost", negative dollar value is a "savings"

Note: Estimate of $2,000,000 for capital costs is not based on any actual calculation, it is
simply input as placeholder to illustrate potential payback period
a Wind FS is planned by Project Team, which would refine capital costs

APPENDIX C-2

Use of Variable Frequency Drives on Air Stripper Motors

Appendix C2
Assumptions for SiteWise Input and Other Calculations
Hastings Pilot GSR Evaluation

Use of Variable Frequency Drives on Air Stripper Blower Motors

The power to operate pumps and blowers is proportional to the cube of the pump or blower speed. Based on this relationship, the following equation is used to estimate the electricity used by a motor with a VFD.

$$kWh = \frac{HP \times L_V^{\ 3}}{\eta_m \times \eta_v} \times 0.746 \times hours$$

kWh = kilowatt-hours of electricity
HP = horsepower
L_V = % of VFD full load (or speed in Hertz divided by 60 Hertz)
η_m = motor efficiency (assume 85%)
η_v = efficiency of VFD (90% for VFD speed settings over 75% of full speed)
hours = hours of operation over time frame of project

The blowers both have 20 HP motors (input into SiteWise), and the electricity usage for the Baseline Option (reported from SiteWise) is 7,800,000 kWh. Based on the above equation and assuming the VFD can be set at 85% of full speed, the electricity use for the blowers with a VFD would be approximately 6,300,000 kWh. This results in a savings of approximately 1.5 million kWh over the course of the remedy.

To calculate the footprint reductions for this much electricity, in SiteWise the estimated reduction of 1,500,000 kWh was input into the SiteWise “Alternative 2” directory, Input Sheet, Remedial Investigation tab, using the “Pump 1” cell, and “Method 1”. The following table summarizes the energy, CO2e, NOx, SOx, and water footprints from SiteWise associated with this estimated electricity reduction over the life of the project based on SiteWise output in the Alternative 2 directory, Remedial Investigation.xls sheet, reported on the “equipment use - pumps” tab.

GSR Parameter	Footprint Reduction In SiteWise Units
Energy	16,000 MMBtu
CO2e	1,300 metric tons
NOx	2.6 metric tons
SOx	4.5 metric tons
Water	770,000 gallons

A cost spreadsheet is also attached. The GSR team estimates an upfront cost of $7,500 to furnish and install the VFDs during remedy construction. Annual cost savings are estimated based on a current electricity rate of $0.0658 per kWh, which is the average retail price for electricity in Nebraska according to www.eia.gov on 2/3/11. The annual electrical savings are calculated below based on the estimated electrical savings of 1,500,000 kWh divided by 30 to get an annual result:

- 1,500,000 kWh x $0.0658/kWh / 30 = $3290

Total annual savings is thus estimated at $3,300 per year, which is entered into the cost sheet. Payback would occur in approximately 3 years with and without discounting.

Project: GSR Pilot for Former NAD - Hastings
Option or Alternative: Changes due to Alternative 2: Use of VFDs on air stripper motors
Current Date: 2/5/2011

year	up-front cost	annual cost	present value of cost each year	cumulative cash flow	
		(no discounting)	3%	no discounting	3%
0	$7,500	$0	$7,500	$7,500	$7,500
1	$0	-$3,300	-$3,204	$4,200	$4,296
2	$0	-$3,300	-$3,111	$900	$1,186
3	$0	-$3,300	-$3,020	-$2,400	-$1,834
4	$0	-$3,300	-$2,932	-$5,700	-$4,766
5	$0	-$3,300	-$2,847	-$9,000	-$7,613
6	$0	-$3,300	-$2,764	-$12,300	-$10,377
7	$0	-$3,300	-$2,683	-$15,600	-$13,060
8	$0	-$3,300	-$2,605	-$18,900	-$15,665
9	$0	-$3,300	-$2,529	-$22,200	-$18,194
10	$0	-$3,300	-$2,456	-$25,500	-$20,650
11	$0	-$3,300	-$2,384	-$28,800	-$23,034
12	$0	-$3,300	-$2,315	-$32,100	-$25,348
13	$0	-$3,300	-$2,247	-$35,400	-$27,595
14	$0	-$3,300	-$2,182	-$38,700	-$29,777
15	$0	-$3,300	-$2,118	-$42,000	-$31,895
16	$0	-$3,300	-$2,056	-$45,300	-$33,952
17	$0	-$3,300	-$1,997	-$48,600	-$35,948
18	$0	-$3,300	-$1,938	-$51,900	-$37,887
19	$0	-$3,300	-$1,882	-$55,200	-$39,769
20	$0	-$3,300	-$1,827	-$58,500	-$41,596
21	$0	-$3,300	-$1,774	-$61,800	-$43,370
22	$0	-$3,300	-$1,722	-$65,100	-$45,092
23	$0	-$3,300	-$1,672	-$68,400	-$46,764
24	$0	-$3,300	-$1,623	-$71,700	-$48,387
25	$0	-$3,300	-$1,576	-$75,000	-$49,963
26	$0	-$3,300	-$1,530	-$78,300	-$51,494
27	$0	-$3,300	-$1,486	-$81,600	-$52,979
28	$0	-$3,300	-$1,442	-$84,900	-$54,422
29	$0	-$3,300	-$1,400	-$88,200	-$55,822
30	$0	-$3,300	-$1,360	-$91,500	-$57,181

Net Present Value (NPV)-> -$57,181

*positive dollar value is a "cost", negative dollar value is a "savings"

APPENDIX C-3

Use of Variable Frequency Drives on Extraction Pumps

Appendix C3
Assumptions for SiteWise Input and Other Calculations
Hastings Pilot GSR Evaluation

Use of Variable Frequency Drives on Extraction Pumps

The power to operate pumps and blowers is proportional to the cube of the pump or blower speed. Based on this relationship, the following equation is used to estimate the electricity used by a motor with a VFD.

$$kWh = \frac{HP \times L_V{}^3}{\eta_m \times \eta_v} \times 0.746 \times hours$$

kWh = kilowatt-hours of electricity
HP = horsepower
L_V = % of VFD full load (or speed in Hertz divided by 60 Hertz)
η_m = motor efficiency
η_v = efficiency of VFD (90% for VFD speed settings over 75% of full speed)
hours = hours of operation over time frame of project

The head produced by a pump is the square of the pump speed and the flow rate is directly proportional to the pump speed. Because the extraction rate at each well is expected to vary over the course of the remedy, the extraction pumps need to be sized to provide the maximum extraction rate (i.e., the pumping rates are expected to vary over the course of the remedy in 5-year periods). During some pumping periods, however, the extraction rate at some wells will need to be reduced to allow capacity to increase at other wells. The input into SiteWise assumes 15 HP extraction pumps for 21 wells for a total of 315 HP for extraction well pumps. Using a Grundfos 230S150-5B or equivalent, this assumes that each well could pump between 50 gpm and 225 gpm. This is a simplifying assumption. There is substantially more variation planned for some of the pumps.

A review of the pump curve modified by pump speed suggests that the pump could provide the 155 gpm at an average total dynamic head of approximately 160 ft at 87% of the full pump speed. Based on the above equation, using a VFD and a pump speed of 87%, the electricity use for the extraction wells with VFDs would be approximately 55,783,000 kWh or 55,783 MWh. Compared to the baseline 66,000 MWh for pumps throttled with a valve, using these assumptions, a VFD yields a savings of approximately 10,217 MWh over the course of the remedy.

To calculate the footprint reductions for this much electricity, in SiteWise the estimated reduction of 10,217,000 kWh was input into the SiteWise “Alternative 2” directory, Input Sheet, Remedial Action Construction tab, using the “Pump 1” cell and “Method 1”. The following table summarizes the energy, CO2e, NOx, SOx, and water footprints from SiteWise associated with this estimated electricity reduction over the life of the project, based on SiteWise output in the Alternative 2 directory, Remedial Action Construction.xls sheet, reported on the “equipment use - pumps” tab.

GSR Parameter	Footprint Reduction In SiteWise Units
Energy	110,000 MMBtu
CO2e	9,100 metric tons
NOx	18 metric tons
SOx	31 metric tons
Water	5,200,000 gallons

A cost spreadsheet is also attached. The GSR team estimates an upfront cost of $63,000 to furnish and install the VFDs during remedy construction. Annual cost savings are estimated based on a current electricity rate of $0.0658 per kWh, which is the average retail price for electricity in Nebraska according to www.eia.gov on 2/3/11. The annual electrical savings are calculated below based on the estimated electrical savings of 10,217,000kWh divided by 30 to get an annual result:

- 10,217,000 kWh x $0.0658/kWh / 30 = $22,409

Total annual savings is thus estimated at $22,400 per year, which is entered into the cost sheet. Payback would occur in approximately 3 years with and without discounting.

Project: GSR Pilot for Former NAD - Hastings
Option or Alternative: Changes due to Alternative 3: Use of VFDs on extraction pumps
Current Date: 2/5/2011

year	up-front cost	annual cost	present value of cost each year	cumulative cash flow	
		(no discounting)	3%	no discounting	3%
0	$63,000	$0	$63,000	$63,000	$63,000
1	$0	-$22,400	-$21,748	$40,600	$41,252
2	$0	-$22,400	-$21,114	$18,200	$20,138
3	$0	-$22,400	-$20,499	-$4,200	-$361
4	$0	-$22,400	-$19,902	-$26,600	-$20,263
5	$0	-$22,400	-$19,322	-$49,000	-$39,585
6	$0	-$22,400	-$18,760	-$71,400	-$58,345
7	$0	-$22,400	-$18,213	-$93,800	-$76,558
8	$0	-$22,400	-$17,683	-$116,200	-$94,241
9	$0	-$22,400	-$17,168	-$138,600	-$111,409
10	$0	-$22,400	-$16,668	-$161,000	-$128,077
11	$0	-$22,400	-$16,182	-$183,400	-$144,259
12	$0	-$22,400	-$15,711	-$205,800	-$159,970
13	$0	-$22,400	-$15,253	-$228,200	-$175,223
14	$0	-$22,400	-$14,809	-$250,600	-$190,032
15	$0	-$22,400	-$14,378	-$273,000	-$204,410
16	$0	-$22,400	-$13,959	-$295,400	-$218,369
17	$0	-$22,400	-$13,552	-$317,800	-$231,921
18	$0	-$22,400	-$13,158	-$340,200	-$245,079
19	$0	-$22,400	-$12,774	-$362,600	-$257,853
20	$0	-$22,400	-$12,402	-$385,000	-$270,255
21	$0	-$22,400	-$12,041	-$407,400	-$282,297
22	$0	-$22,400	-$11,690	-$429,800	-$293,987
23	$0	-$22,400	-$11,350	-$452,200	-$305,337
24	$0	-$22,400	-$11,019	-$474,600	-$316,356
25	$0	-$22,400	-$10,698	-$497,000	-$327,055
26	$0	-$22,400	-$10,387	-$519,400	-$337,441
27	$0	-$22,400	-$10,084	-$541,800	-$347,526
28	$0	-$22,400	-$9,791	-$564,200	-$357,316
29	$0	-$22,400	-$9,505	-$586,600	-$366,821
30	$0	-$22,400	-$9,229	-$609,000	-$376,050

Net Present Value (NPV)-> -$376,050

*positive dollar value is a "cost", negative dollar value is a "savings"

APPENDIX C-4

Change from Air Stripping to Liquid GAC

Appendix C4
Assumptions for SiteWise Input and Other Calculations
Hastings Pilot GSR Evaluation

Change from Air Stripping to Liquid GAC

In the 30 Percent Design (Table A-5) the Project Team considered the potential use of GAC in place of air stripping and estimated approximately 1.66 million pounds of GAC would be used over the life of the remedy. The use of GAC in place of air stripping would alter many of the footprints. SiteWise was used to estimate some of these footprints for both virgin and regenerated GAC. To preserve most of the input from the baseline remedy, the SiteWise Input Sheet.xls was copied from the Alternative 1 directory to Alternative 3 directory to model virgin GAC and to the Alternative 4 directory to model regenerated GAC. Changes were then made to the input for the LongTerm Monitoring tab of the input sheet which was used in the Baseline Option for the O&M components of the footprint.

The following changes were made to the Longterm Monitoring tab of the copied SiteWise Input Sheet.xls in Alternative 3 to model virgin GAC.

- The electricity use for the blowers was deleted because blower operation would no longer be required.
- 1,668,000 lbs of Virgin GAC was added to the "Treatment 1" entry under GAC.
- Personnel transportation trips are reduced by 50% to account for simplified operation of the GAC system relative to the air stripping system.
- Mileage and tonnage were added to "Trip 1" under the Equipment Transportation – Road section as follows:
    - 45 deliveries over the course of the 30-year remedy
    - GAC facility located 500 miles from the site
    - 45,000 miles accounts for 45 roundtrips to and from a GAC facility (1,000 miles roundtrip).
    - An average of 9.3 tons of GAC per trip based on 18.5 tons one-way and 0 tons for the empty return trip (18.5 tons ×45 trips ×2000 pounds per ton = 1,668,000 lbs of GAC)

The following changes were made to the Longterm Monitoring tab of the copied SiteWise Input Sheet.xls in Alternative 4 to model regenerated GAC.

- The electricity use for the blowers was deleted because blower operation would no longer be required.
- Personnel transportation trips are reduced by 50% to account for simplified operation of the GAC system relative to the air stripping system.
- Mileage and tonnage were added to "Trip 1" under the Equipment Transportation – Road section as follows:
    - 45 deliveries over the course of the 30-year remedy
    - GAC facility located 500 miles from the site
    - 45,000 miles accounts for 45 roundtrips to and from a GAC facility (1,000 miles roundtrip).
    - An average of 9.3 tons of GAC per trip based on 18.5 tons one-way and 0 tons for the empty return trip (18.5 tons ×45 trips ×2000 pounds per ton = 1,668,000 lbs of GAC)

SiteWise does not have the ability to select regenerated GAC in the input sheet. Therefore, the 1,668,000 lbs of regenerated GAC is added to the “user input” column under GAC in the Longterm Monitoring.xls sheet (“materials production” tab) in Alternative 4.

The following table summarizes various environmental footprint parameters from the Summary tab of the Longterm Monitoring.xls sheets in Alternative 1 (Baseline Remedy) , Alternative 3 (Virgin GAC option), and Alternative 4 (Regenerated GAC option).

GSR Parameter	**Baseline Remedy (O&M Only)**	**Virgin GAC Option (O&M Only)**	**Regenerated GAC Option (O&M Only)**
Energy (MMBtu)	768,000	774,000	688,000
CO2e (metric tons)	66,438	64,329	60,206
Risk (On-Site)	0	0	0
Risk (Transportation)	0.0831	0.064	0.064

Note that SiteWise does not provide footprint information for NOx, SOx, and water for GAC. Therefore, changes in these footprints are not known and are not shown in the above table.

The use of refined and unrefined materials, which is not quantified by SiteWise, would also be modified by using GAC. For O&M, the baseline option has a negligible amount of refined and unrefined materials use. The GAC option would increase the refined materials use by 1,668,000 lbs. For virgin GAC, this use would be considered from non-recycled material. For regenerated GAC, this use would be considered from recycled materials.

A cost spreadsheet is also attached. Based on Tables A-1 and A-5 of the 30 Percent Design, the capital cost of the GAC would be approximately $150,000 more than the air stripping. The estimated difference in annual costs for changing to carbon is as follows:

- Carbon cost is an additional $127,900 per year from Table A-6 of the 30 Percent Design

- Electricity is a reduction because the blowers are no longer needed. The total electric use of the blowers is 7,800,000 kWh over 30 years. Savings per year is

  7,800,000 kWh x $0.0658/kWh / 30 = $17,108

- Assume 24 visits per year are cut by 4 hours each , and assume rate of $50/hr, yields labor savings per year of 24 x 4 x $50 = $4,800

Thus total annual change is an increase of $127,900 - $17,108 - $4,800 = ~$106,000/yr.

Since there is both a capital cost and annual cost, there will be no payback period.

Project: GSR Pilot for Former NAD - Hastings
Option or Alternative: Changes due to Alternative 4: Change from air stripping to liquid GAC
Current Date: 2/5/2011

year	up-front cost	annual cost	present value of cost each year	cumulative cash flow	
		(no discounting)	3%	no discounting	3%
0	$150,000	$0	$150,000	$150,000	$150,000
1	$0	$106,000	$102,913	$256,000	$252,913
2	$0	$106,000	$99,915	$362,000	$352,828
3	$0	$106,000	$97,005	$468,000	$449,833
4	$0	$106,000	$94,180	$574,000	$544,012
5	$0	$106,000	$91,437	$680,000	$635,449
6	$0	$106,000	$88,773	$786,000	$724,222
7	$0	$106,000	$86,188	$892,000	$810,410
8	$0	$106,000	$83,677	$998,000	$894,087
9	$0	$106,000	$81,240	$1,104,000	$975,328
10	$0	$106,000	$78,874	$1,210,000	$1,054,202
11	$0	$106,000	$76,577	$1,316,000	$1,130,778
12	$0	$106,000	$74,346	$1,422,000	$1,205,124
13	$0	$106,000	$72,181	$1,528,000	$1,277,305
14	$0	$106,000	$70,078	$1,634,000	$1,347,384
15	$0	$106,000	$68,037	$1,740,000	$1,415,421
16	$0	$106,000	$66,056	$1,846,000	$1,481,477
17	$0	$106,000	$64,132	$1,952,000	$1,545,609
18	$0	$106,000	$62,264	$2,058,000	$1,607,872
19	$0	$106,000	$60,450	$2,164,000	$1,668,323
20	$0	$106,000	$58,690	$2,270,000	$1,727,012
21	$0	$106,000	$56,980	$2,376,000	$1,783,993
22	$0	$106,000	$55,321	$2,482,000	$1,839,313
23	$0	$106,000	$53,709	$2,588,000	$1,893,022
24	$0	$106,000	$52,145	$2,694,000	$1,945,167
25	$0	$106,000	$50,626	$2,800,000	$1,995,794
26	$0	$106,000	$49,152	$2,906,000	$2,044,945
27	$0	$106,000	$47,720	$3,012,000	$2,092,665
28	$0	$106,000	$46,330	$3,118,000	$2,138,995
29	$0	$106,000	$44,981	$3,224,000	$2,183,976
30	$0	$106,000	$43,671	$3,330,000	$2,227,647

Net Present Value (NPV)-> $2,227,647

*positive dollar value is a "cost", negative dollar value is a "savings"

APPENDIX C-5

Build Two Treatment Plants

Appendix C5
Assumptions for SiteWise Input and Other Calculations
Hastings Pilot GSR Evaluation

Change from One to Two Treatment Systems

The current treatment system is located between to distant extraction systems and requires substantial piping to convey water from the extraction systems. This piping adds to GSR parameters during construction and adds to the friction loss component of total dynamic head for pumping during the O&M phase. Constructing two separate, optimally located treatment systems would reduce the piping. The following assumptions are made regarding piping, building construction, and pumping for an option with two treatment systems:

- Building construction and resources would be equivalent to the one treatment system option because two smaller systems would be used in place of one large building. Because of the duplication of equipment, controls, and design, it is assumed that the cost of two treatment systems is 50% higher than the one treatment system option

- For the NE System, the 22-inch piping would be eliminated.

- For the SE System, the 14-inch piping would be eliminated

- The effluent piping resources and effort would remain unchanged as a simplifying assumption.

- Friction loss during pumping is reduced by approximately 2 feet per 1000 feet of piping and the treatment systems are centrally located in each extraction network such that there is a similar piping distance from each well to the respective treatment plant.

- There is negligible elevation change between the extraction wells and the respective treatment plant.

- The pumps are fitted with VFDs. The VFD settings for the NE System remain the same as the previously discussed VFD option (87%). The VFD settings for the SE System can be reduced to 83.5% based on a review of the pump curve (modified for pump speed) and the reduced friction loss from the eliminated piping.

The following tables are taken from the notes for the baseline remedy modified to reflect the eliminated piping mentioned in the above bullets.

- NE system

Size	Length (ft)	HDPE (lbs/ft)	Trench X-Sect. Area (ft2)	Trench Volume (cy)	HDPE Mass (lbs)
6-inch	5,000	5	10	1,851	25,000
8-inch	13,000	8.4	10	4,815	109,200
12-inch	1,400	18.4	10	519	25,760

Size	Length (ft)	HDPE (lbs/ft)	Trench X-Sect. Area (ft2)	Trench Volume (cy)	HDPE Mass (lbs)
16-inch	2,600	29.0	15	1,444	75,400
20-inch	2,600	45.3	18	1,733	117,780
Total	24,600			10,362	353,140
					5996 ft3

*Mass = 117,780 lbs * 1cf/58.9 lbs = 5,996 cf for volume of HDPE*

- SE system

Size	Length (ft)	HDPE (lbs/ft)	Trench X-Sect. Area (ft2)	Trench Volume (cy)	HDPE Mass (lbs)
6-inch	4,600	5	10	1,704	23,000
8-inch	7,000	8.4	10	2,593	58,800
12-inch	6,400	18.4	10	2,370	117,760
Total	18,000		**Total**	6,667	119,560
					3,388 ft3

*Mass = 119,560 lbs * 1cf/58.9 lbs = 3,388 cf for volume of HDPE*

The total electricity for pumping with the VFDs are as follows:

NE System

$$kWh = \frac{HP \times L_V^{\,3}}{\eta_m \times \eta_v} \times 0.746 \times hours = 39{,}845{,}000\,kWh$$

kWh = kilowatt-hours of electricity
HP = horsepower (15 pumps at 15 HP each = 215 HP)
L_V = % of VFD full load (or speed in Hertz divided by 60 Hertz)= 87% (see Option 3 notes)
η_m = motor efficiency = 81%
η_v = efficiency of VFD (90% for VFD speed settings over 75% of full speed)
hours = hours of operation over time frame of project = 262,800 over 30 years

SE System

$$kWh = \frac{HP \times L_V^{\,3}}{\eta_m \times \eta_v} \times 0.746 \times hours = 13{,}839{,}000\,kWh$$

kWh = kilowatt-hours of electricity
HP = horsepower (15 pumps at 15 HP each = 215 HP)
L_V = % of VFD full load (or speed in Hertz divided by 60 Hertz)= 83.5% (see Option 3 notes)
η_m = motor efficiency = 81%
η_v = efficiency of VFD (90% for VFD speed settings over 75% of full speed)
hours = hours of operation over time frame of project = 262,800 over 30 years

The following changes were made to the SiteWise Input Sheetl.xls file:

- Remedial Investigation Tab (input for extraction well installation) – No changes

- Remedial Action Construction Tab (input for piping installation)
    - Construction Materials
        - Material 1 – Changed from 7,670 ft3 of HDPE to the 5,996 ft3 in the above table for the NE System
        - Material 2 – Changed from 10,399 ft3 to the 3,388 ft3 of HDPE in the above table for the SE System
    - Personnel Transportation – Road
        - Trip 1 – Changed to 182 trips based on total HDPE pipe length (24,600+18,000+3,000 ft = 45,600) divided by a productivity rate of 250 feet per day (45,600 / 250 = 182 trips) for a crew of four for pipe laying.
        - Trip 2 - Changed to 71 trips based on total equipment hours calculated by SiteWise divided by 8 hours per day.
        - Trip 3 – Round-trips for heavy equipment (one round-trip per piece of equipment and two pieces of equipment for each extraction system)
        - Trip 4 – Round-trips for consultant from Lenexa, KS on a weekly basis. Assumes contractor work is accomplished by two parallel crews and that total work takes 35 days resulting in 7 weekly trips.
        - Trip 5 –Round-trips for consultant to and from hotel on a daily basis for 35 days.
    - Equipment Transportation – Road
        - Trip 1 – Mileage and tonnage for transporting HDPE for NE System. Assumes distance of 500 miles for shipping, plus an empty return trip for a total of 1,000 miles per trip. Number of trips is determined based on hauling approximately 20 tons per load. Reported mileage is the number of trips multiplied by 1,000 miles per trip. Tonnage is equal to the total weight hauled, divided by the number of trips (for approximately 20 tons), divided by 2 to provide an average of the tonnage for the delivery trip and empty return trip.
        - Trip 2 – Mileage and tonnage for transporting HDPE for SE System. Same assumptions regarding data entry for NE System apply to the SE System.
        - Trip 3 – Mileage and tonnage for transporting HDPE for effluent piping. Same assumptions regarding data entry for NE System apply to the effluent piping.
    - Earthwork
        - Equipment 1 – Cubic yards of excavation for NE trenching from above table
        - Equipment 2 – Cubic yards of excavation for SE trenching from above table
        - Equipment 3 – Cubic yards of excavation for effluent piping from above table
- Remedial Action Operations Tab (input for building construction) – No changes
- Longterm Monitoring Tab (input for O&M)
    - Personnel Transportation – Road – No changes assumes operator trips and mileage is unchanged.
    - Pump Operation
        - Pump 1
            - Change method from Method 3 to Method 1
            - Enter 39,845,000 from above calculation for NE System into “Input pump electrical usage (kWh)”
        - Pump 2
            - Change method from Method 3 to Method 1
            - Enter 13,839,000 from above calculation for SE System into “Input pump electrical usage (kWh)”

A comparison of the Baseline Remedy, a remedy that uses of VFDs for extraction pumps, and this approach (two treatment plants with VFDs for extraction pumps) is presented in the following table. Results are obtained from the Remedial Investigation, Remedial Action Construction, Remedial Action Operations, and Longterm Monitoring sheets in Alternatives 1, 2, and 5.

GSR Parameter	Baseline Remedy	VFDs for Extraction Pumps	Two Treatment Buildings and VFDs for Extraction Pumps
Energy (MMBtu)	830,000	720,000	710,000
CO2e (metric tons)	68,000	58,900	58,000
NOx (metric tons)	130	112	110
SOx (metric tons)	220	189	190
Risk (On-Site)	0.027	0.027	0.019
Risk (Transportation)	0.172	0.172	0.146
Refined materials use (lbs)	1,874,000	1,874,000	1,282,440

A cost spreadsheet is also attached that uses the following assumptions:

- The cost for constructing two smaller buildings instead of one single, larger building is approximately 50% higher. The capital cost in Table 5 of the ROD for the "Treatment Systems and Related Infrastructure" is $1,755,000. A 50% increase would be approximately $877,500.

- The cost for piping to the treatment systems in table 5 of the ROD is $4,775,000. Based on the above notes for the Baseline remedy, a total of 63,000 feet of extraction system piping is installed. This translates to a unit cost of approximately $76 per foot of pipe. The two-building approach uses a total of 42,600 feet of piping, for a reduction of 20,400 feet. Using the unit rate of $76 per foot, this translates to a capital savings of $1,550,400.

- The VFDs used on the extraction pumps costs $63,000 for installation.

- There is no additional cost for operator labor. The operator can maintain the two systems for the same approximate cost as the one larger system.

- Approximately 410,533 kWh of electricity is saved each year by reducing the amount of piping and using VFDs on the extraction pumps as follows:

  - 66,000,000 kWh used over the lifetime of the baseline remedy
  - 39,845,000 kWh used over the lifetime of the NE System with VFDs
  - 13,839,000 kWh used over the lifetime of the SE System with reduced piping and VFDs
  - 66,000,000 – 39,845,000 – 13,839,000 = 12,316,000 kWh
  - 12,316,000 kWh / 30 years = 410,533 kWh/yr

  This reduction in electricity use translates to a cost savings of approximately $27,000 per year, using $0.0658 per kWh, which is the average retail price for electricity in Nebraska according to www.eia.gov on 2/3/11.

Project: GSR Pilot for Former NAD - Hastings
Option or Alternative: Changes due to Alternative 5: Build two treatment plants
Current Date: 2/5/2011

year	up-front cost	annual cost	present value of cost each year	cumulative cash flow	
		(no discounting)	3%	no discounting	3%
0	-$609,900	$0	-$609,900	-$609,900	-$609,900
1	$0	-$27,000	-$26,214	-$636,900	-$636,114
2	$0	-$27,000	-$25,450	-$663,900	-$661,564
3	$0	-$27,000	-$24,709	-$690,900	-$686,273
4	$0	-$27,000	-$23,989	-$717,900	-$710,262
5	$0	-$27,000	-$23,290	-$744,900	-$733,552
6	$0	-$27,000	-$22,612	-$771,900	-$756,164
7	$0	-$27,000	-$21,953	-$798,900	-$778,118
8	$0	-$27,000	-$21,314	-$825,900	-$799,432
9	$0	-$27,000	-$20,693	-$852,900	-$820,125
10	$0	-$27,000	-$20,091	-$879,900	-$840,215
11	$0	-$27,000	-$19,505	-$906,900	-$859,721
12	$0	-$27,000	-$18,937	-$933,900	-$878,658
13	$0	-$27,000	-$18,386	-$960,900	-$897,044
14	$0	-$27,000	-$17,850	-$987,900	-$914,894
15	$0	-$27,000	-$17,330	-$1,014,900	-$932,224
16	$0	-$27,000	-$16,826	-$1,041,900	-$949,050
17	$0	-$27,000	-$16,335	-$1,068,900	-$965,385
18	$0	-$27,000	-$15,860	-$1,095,900	-$981,245
19	$0	-$27,000	-$15,398	-$1,122,900	-$996,643
20	$0	-$27,000	-$14,949	-$1,149,900	-$1,011,592
21	$0	-$27,000	-$14,514	-$1,176,900	-$1,026,106
22	$0	-$27,000	-$14,091	-$1,203,900	-$1,040,197
23	$0	-$27,000	-$13,681	-$1,230,900	-$1,053,877
24	$0	-$27,000	-$13,282	-$1,257,900	-$1,067,160
25	$0	-$27,000	-$12,895	-$1,284,900	-$1,080,055
26	$0	-$27,000	-$12,520	-$1,311,900	-$1,092,575
27	$0	-$27,000	-$12,155	-$1,338,900	-$1,104,730
28	$0	-$27,000	-$11,801	-$1,365,900	-$1,116,531
29	$0	-$27,000	-$11,457	-$1,392,900	-$1,127,988
30	$0	-$27,000	-$11,124	-$1,419,900	-$1,139,112

Net Present Value (NPV)-> -$1,139,112

*positive dollar value is a "cost", negative dollar value is a "savings"

FINAL REPORT

PILOT PROJECT
GREEN AND SUSTAINABLE REMEDIATION EVALUATION: IOWA ARMY AMMUNITION PLANT MIDDLETOWN, IOWA

Prepared for:

U.S. Army Corps of Engineers
Environmental and Munitions Center of Expertise
1616 Capitol Ave, Suite 9200
Omaha, NE 68101-9200

Contract No. W912DQ-08-D-0019
Delivery Order No. ZW02

Prepared by:

Tetra Tech EC, Inc.
1000 American Rd.
Morris Plains, NJ 07950

10 April 2012

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PREFACE

The US Army Engineering and Support Center, Huntsville (USAESCH), Environmental and Munitions Center of Expertise (EM CX) has contracted Tetra Tech EC, Inc. (Tetra Tech) under Contract W912DQ-08-D-0019, Delivery Order No. ZW02, to conduct and document a Study that follows the process of considering, incorporating, documenting, and evaluating the benefits of green and sustainable remediation (GSR) practices. The objective of this Task Order is to: (1) Follow the consideration and incorporation of GSR practices into Army environmental remediation projects; (2) Ascertain the effectiveness of the GSR practices that are considered and incorporated; and (3) Provide procedures by which GSR practices that are shown to be effective can be identified, considered, implemented and documented by Project Teams working on Army sites. The information obtained from this Study will be used to provide recommendations to the Office of the Assistant Chief of Staff for Installation Management (OACSIM) for development of Army-wide GSR guidance and policy. This document has been prepared in accordance with the Task Order Statement of Work (SOW) entitled "*Evaluation of Consideration and Incorporation of Green and Sustainable Remediation (GSR) Practices in Army Environmental Remediation*" (26 July 2010).

The Project Delivery Team (PDT) consists of representatives and subject matter experts (SMEs) from the following organizations:

- EM CX;
- OACSIM;
- National Guard Bureau (NGB);
- Army Environmental Command (AEC);
- Tetra Tech;
- Office of the Deputy Assistant Secretary of the Army-Environment, Safety, and Occupational Health (ODASA (ESOH));
- Headquarters US Army Corps of Engineers (HQ USACE) Formerly Used Defense Sites (FUDS) program;
- HQ USACE Environmental Community of Practice (ECoP) Military Munitions Support Services (M2S2);
- Huntsville Center Environmental Program; and
- Army Environmental Policy Institute (AEPI)

Specific representatives of those organizations are listed on the table at the end of this preface. This report pertains to one of the pilot projects conducted as part of the Study. Tetra Tech personnel who provided the most significant contributions to this report are as follows:

- Preparation
  - Rob Greenwald (Project Manager)
  - Sarah Farron
  - Michelle Caruso (MMRP Lead)

- Review
  - Doug Sutton (IRP GSR Technical Lead)

Sincere thanks are extended to the Project Team associated with this pilot project, for their willingness to participate in this Study and for their efforts that were associated with their participation.

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Professional in Charge:

Douglas J Sutton

Doug Sutton, PhD, PE, LEED

____4/10/12____
Date

ACRONYMS AND ABBREVIATIONS

ACSIM	Assistant Chief of Staff for Installation Management
AEC	Army Environmental Command
AEPI	Army Environmental Policy Institute
AMC	Army Materiel Command
BCY	Bank Cubic Yards
BIP	Blow-in-Place
BMPs	Best Management Practices
CO2	Carbon Dioxide
CO2e	Equivalent Global Warming Potential of Carbon Dioxide
CSM	Conceptual Site Model
CTA	Central Test Area
CTT	Closed, Transferring, and Transferred
DGM	Digital Geophysical Mapping
DoD	Department of Defense
ECoP	Environmental Community of Practice
EM CX	Environmental and Munitions Center of Expertise
ESOH	Environment, Safety, and Occupational Health
ESP	Explosives Site Plan
FS	Feasibility Study
FUDS	Formerly Used Defense Sites
GHG	Greenhouse Gas
GIS	Geographic Information System
GRAs	General Response Actions
GSR	Green and Sustainable Remediation
HQ USACE	Headquarters US Army Corps of Engineers
HRR	Historical Records Review
IAAAP	Iowa Army Ammunition Plant
INDA	Incendiary Disposal Area
IRP	Installation Restoration Program
ISM	Incremental Sampling Methodology
JMC	Joint Munitions Command
Kg	Kilograms
lbs	Pounds
LL6	Line 6 Ammo Production (Inside Blast Radii)
LUCs	Land Use Controls
M2S2	Military Munitions Support Services
MC	Munitions Constituents
MD	Munitions Debris
MEC	Munitions and Explosives of Concern
MMBtu	Million Metric British Thermal Units
MMRP	Military Munitions Response Program
MRS	Munitions Response Site
NFA	No Further Action
NGB	National Guard Bureau
NOx	Nitrogen Oxides

ACRONYMS AND ABBREVIATIONS

NPV	Net present value
O&M	Operations and Maintenance
OACSIM	Office of the Assistant Chief of Staff for Installation Management
ODASA	Office of the Deputy Assistant Secretary of the Army
PDS	Possible Demolition Site
PDT	Project Delivery Team
PM	Particulate Matter
RA	Remedial Action
RAB	Restoration Advisory Board
RAOs	Remedial Action Objectives
RECs	Renewable Energy Certificates
RDX	hexahydro-1,3,5-trinitro-1,3,5-triazine
RI	Remedial Investigation
RI/FS	Remedial Investigation / Feasibility Study
SI	Site Investigation or Site Inspection
SiteWise	Battelle SiteWise™ Sustainable Environmental Remediation Tool
SMEs	Subject Matter Experts
SOW	Statement of Work
SOx	Sulfur Oxides
US	United States
USACE	United States Army Corps of Engineers
USAESCH	US Army Engineering and Support Center, Huntsville
UXO	Unexploded Ordnance
yrs	Years

1.0 INTRODUCTION

1.1 ACSIM GSR STUDY AND PURPOSE OF THIS GSR EVALUATION

The US Army Engineering and Support Center, Huntsville (USAESCH), Environmental and Munitions Center of Expertise (EM CX) has contracted Tetra Tech EC, Inc. (Tetra Tech) under Contract W912DQ-08-D-0019, Delivery Order No. ZW02, to conduct and document a Study that follows the process of considering, incorporating, documenting, and evaluating the benefits of green and sustainable remediation (GSR) practices (hereafter referred to as "the Study"). Pursuant to the Department of Defense (DoD) Memorandum "*Consideration of Green and Sustainable Remediation Practices in the Defense Environmental Restoration Program*" (DoD, 2009), GSR employs strategies throughout the remedial process that:

- Use natural resources and energy efficiently;
- Reduce negative impacts on the environment;
- Minimize or eliminate pollution at its source;
- Protect and benefit the community at large; and
- Reduce waste to the greatest extent possible.

The objective of the Study is to: (1) Follow the consideration and incorporation of GSR practices into Army environmental remediation projects; (2) Ascertain the effectiveness of the GSR practices that are considered and incorporated; and (3) Provide procedures by which GSR practices that are shown to be effective can be identified, considered, implemented and documented by Project Teams working on Army sites. The information obtained from this Study will be used to provide recommendations to the Office of the Assistant Chief of Staff for Installation Management (OACSIM) for development of Army-wide GSR guidance and policy.

One component of the Study is to perform a GSR evaluation at 12 Army "Pilot Projects" that are in various phases of the remedial process. This report presents the Pilot Project GSR Evaluation for the following Munitions Response Sites (MRSs) at the Iowa Army Ammunition Plant (IAAAP) in Middletown, Iowa:

- Central Test Area (CTA)
- Line 6 Ammo Production (Inside Blast Radii) (LL6)
- Possible Demolition Site (PDS)
- Incendiary Disposal Area (INDA)

This GSR evaluation has been conducted using an approach developed during the Study and documented in the following report: *Process for Consideration and Incorporation of Green and Sustainable Remediation (GSR) Practices in Army Environmental Remediation (final report dated 26 May 2011).* One purpose for the pilot projects is to provide testing of the GSR approach developed during the Study. That approach will be refined and finalized later in the Study based on lessons learned from this and other pilot projects. In addition, it is anticipated that this GSR evaluation will provide the Project Team for IAAAP with information and/or recommendations that will be beneficial for their project.

This report refers to "teams" that are defined as follows:

- Study Team: This is the team conducting the Study being led by USACE EM CX that follows the process of considering, incorporating, documenting, and evaluating the benefits of GSR practices for Army projects.

- Project Team: Refers to those associated with implementation of the remedial process for each pilot project.

- GSR Team: Refers to the personnel that perform a specific GSR evaluation. For this Study, the GSR Team consists of personnel from Tetra Tech, which is a contractor to USACE for the Study.

In this Study, an "EM CX liaison" for each of the pilot projects serves as a bridge between the USACE Study project manager (Carol Dona), the Study contractor performing the GSR evaluation (Tetra Tech), and the Project Team manager for the specific pilot. For this pilot project, Nick Stolte served as the EM CX liaison.

1.2 TECHNICAL OVERVIEW

1.2.1 Overview of Site Location and Setting

This GSR evaluation pertains to proposed Remedial Action (RA) alternatives associated with munitions and explosives of concern (MEC) and munitions constituents (MC) contamination at four Munitions Response Sites (MRSs) at the Iowa Army Ammunition Plant (IAAAP) in Middletown, Iowa. IAAAP occupies 19,011 acres adjacent to the town of Middletown in Des Moines County, Iowa shown on Figure 1-1. IAAAP is a government-owned, contractor-operated facility under the command of the United States Army Joint Munitions Command (JMC), Rock Island, Illinois. The IAAAP began production in 1941 as the Iowa Ordnance Plant. The plant was operated by the private contractor Day and Zimmerman with a mission to Load, Assemble, and Pack ammunition. It produced munitions for World War II until August 1945 when plant operations reverted to U.S. Army control. Under U.S. Army control, the plant was used for ammunition storage and surveillance. From 1947 to 1975, the former Atomic Energy Commission occupied portions of the IAAAP and conducted operations concurrently with the Army. In 1951, IAAAP restarted its manufacturing operations as a Government-owned, contractor-operated facility. The plant is now operated by American Ordnance, LLC. Production activities at IAAAP currently include loading, assembling, and packaging of munitions, including projectiles, mortar rounds, warheads, demolition charges, anti-tank mines, and anti-personnel mines. The loading, assembling, and packaging operations use explosive materials and initiating compounds. Other activities at IAAAP include forestry, grazing, agriculture, and outdoor recreation, including hunting and fishing. Future land use at IAAAP is expected to be similar to current land use.

The Military Munitions Response Program (MMRP) was developed to address munitions-related contamination at sites resulting from past munitions-related activities. Previous MMRP investigations at IAAAP included the Closed, Transferring, and Transferred (CTT) Range/Site Inventory Report, Historical Records Review (HRR), and the MMRP Site Inspection (SI). An MMRP Remedial Investigation (RI) was completed on eight MRSs to determine whether Feasibility Studies (FSs), immediate responses, or No Further Action (NFA) decisions were required for each. Four MRSs were carried forward to the FS phase because of unacceptable explosives safety hazards to human health or the environment at each MRS. Four MRSs were recommended for NFA based on the RI results.

1.2.2 Contamination, Remedial Phase and Status

An FS is currently being conducted to identify and evaluate alternatives for remedial actions for the four MRSs identified during the RI which present unacceptable explosives safety hazards to human health or the environment. The MRSs are as follows (MRS boundaries shown on Figure 1-2):

- Central Test Area (CTA) – FS for MEC and NFA for MC
- Line 6 Ammo Production (Inside Blast Radii) (LL6) – FS for MEC and NFA for MC
- Possible Demolition Site (PDS) – FS for MEC and MC
- Incendiary Disposal Area (INDA) – FS for MEC and NFA for MC

The FS process consists of the following general steps:

- Establish remedial action objectives (RAOs) resulting from the remediation action goals that were developed during the RI.
- Develop general response actions (GRAs) (e.g., land use controls) that may be taken to satisfy the RAOs.
- Identify volumes or areas of media to which GRAs may be applied.
- Identify and evaluate technology process options based on effectiveness, implementability, and relative cost to select a representative process option for each technology type.
- Assemble the selected representative technologies into alternatives representing a range of GRA combinations, as appropriate.
- Where numerous options have been identified, screen alternatives based on the criteria of effectiveness, implementability, and cost to reduce the number of alternatives to analyze in detail.

The Draft FS Report (November 2011) presents three alternatives for MEC remediation at each of the four MRSs, and an additional three alternatives for MC remediation at the PDS MRS. The alternatives presented in the Draft FS include the following:

- MEC Alternatives
    - MEC Alternative 1 – No Further Action
    - MEC Alternative 2 – Land Use Controls
    - MEC Alternative 3 – MEC Subsurface Clearance

- MC Alternatives
    - Alternative 1 – No Action
    - MC Alternative 2 – Land Use Controls
    - MC Alternative 3 – Removal with Off-Site Disposal

The Draft FS recommends MEC Alternative 2 for all four MRSs (CTA, LL6, PDS, and INDA) and MC Alternative 3 for the PDS MRS. This GSR evaluation provides an evaluation of the proposed alternatives at each MRS with respect to specific GSR metrics, and also highlights how specific GSR Best Management Practices (BMPs) have been implemented in previous remedial activities and/or could be implemented during the upcoming remedial actions. However, this GSR evaluation does not in any manner include an evaluation or judgment of the protectiveness of the proposed alternatives.

1.3 DOCUMENTS REVIEWED AND CALLS/MEETINGS CONDUCTED

The following project documents were reviewed for this evaluation:

- *Draft Feasibility Study Report, Military Munitions Response Program, Iowa Army Ammunition Plant, Middletown, Iowa* (November 2011)

Pursuant to the GSR approach implemented in the Study, an introductory conference call (referred to as the "Step 3" call) was conducted on 31 March 2011. During this call, the timing of the GSR evaluation within the overall schedule of the MMRP project at IAAAP was discussed. Participants for the "Step 3" call are listed in Table 1-1.

Table 1-1
Step 3 Call Participants, 31 March 2011

Participants			
Name	**Organization**	**Phone**	**Email**
Carol Dona	EM CX	402.697.2582	Carol.L.Dona@usace.army.mil
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Sarah Farron	Tetra Tech	732.409.0344	sarah.farron@tetratech.com

A more detailed conference call, referred to as the "Step 5" conference call, was conducted on 21 November 2011. During this call the GSR Team used the list of GSR BMPs developed for the Study as an outline to ask questions to the Project Team and allow the Project Team to provide pertinent information to the GSR Team. Participants for the "Step 5" call are listed in Table 1-2.

Table 1-2
Step 5 Call Participants, 21 November 2011

Participants			
Name	**Organization**	**Phone**	**Email**
Carol Dona	EM CX	402.697.2582	Carol.L.Dona@usace.army.mil
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Sarah Farron	Tetra Tech	732.409.0344	sarah.farron@tetratech.com

Jim Bard (AEC) was not able to attend this call.

1.4 STRUCTURE OF THIS REPORT

This GSR evaluation report is structured as follows:

- Section 1: Introduction
- Section 2: Key GSR Findings
    - Review of BMPs
    - Quantitative Footprint Analysis for Remedial Alternatives
        - MEC Alternatives at CTA, LL6, PDS, and INDA
        - MC Alternatives at PDS
    - Other Qualitative Considerations
- Section 3: GSR Recommendations

Supporting information and calculations for quantitative aspects of the evaluation are provided in appendices, and spreadsheet files for the SiteWise tool are attached electronically.

2.0 KEY GSR FINDINGS

2.1 REVIEW OF BEST MANAGEMENT PRACTICES (BMPs)

2.1.1 BMP Tables Completed by GSR Team

The GSR Team and the Project Team used a list of GSR BMPs as an outline to exchange information and ideas pertinent to application of GSR practices for this pilot project. The GSR Team subsequently completed the BMP tables included in Appendix A, based on the data provided by the Project Team in the form of documents as well as discussions during the Step 5 call. Table 2-1 summarizes information entered on the BMP tables in Appendix A, specifically with respect to the number of BMPs that appear to be applicable for this pilot project, the number of BMPs that appear to be practical for this pilot project, the number of BMPs that have been implemented prior to this GSR evaluation, and the number of BMPs that maybe associated with potential cost savings for this pilot project.

Table 2-1
Summary of BMP Applicability and Implementation from BMP Tables in Appendix A

	BMP Category								
	A. Planning	B. Characterization and/or Remedy Approach	C. Energy/Emissions Transportation	D. Energy/Emissions Equipment Use	E. Materials & Off-site Services	F. Water Resource Use	G. Waste Generation, Disposal, and Recycling	H. Land Use, Ecosystems, and Cultural Resources	I. Safety and Community
Total Number of BMPs	10	9	4	11	5	5	6	7	7
Number of Applicable BMPs	9	7	4	2	2	1	3	5	4
Number of Practical BMPs	8	6	4	0	1	1	1	5	4
Number of BMPs Implemented Prior to GSR Evaluation									
- Fully	4	6	4	0	1	1	1	5	4
- Partially	2	0	0	0	0	0	0	0	0
- Not Yet	2	0	0	0	0	0	0	0	0
Number of Practical BMPs Likely to Result in Cost Savings	5	5	4	0	1	0	0	0	1

2.1.2 Key Findings Regarding BMPs

An overview of key findings regarding application of the BMPs to this pilot project is provided below.

- The Project Team has already considered many of the BMPs prior to this GSR evaluation. Examples include the following:

    - Minimizing disturbances to land and vegetation in order to preserve habitat for the Indiana Bat, a federally listed endangered species, and other wildlife. In addition, tree removal and the use of heavy equipment are avoided between April 15 and September 15 so as not to disturb the Indiana Bat.

    - Using teleconferencing rather than meetings with regulators, and conducting meetings in person only when necessary. Attempts are also made to schedule meetings around the same time as RAB meetings so that both meetings can be accomplished in one trip.

    - Developing a CSM and reviewing historical documents and records to reduce the required amount of active investigation and remediation, which are inherent parts of MMRP projects.

    - Using existing structures and reducing waste by leaving existing fencing in place and, to the extent possible, utilizing that fencing rather than installing additional fencing. If the existing fencing is not adequate, the additional fencing would be installed without removing the old.

    - Consolidating loads to reduce trips, by removing all of the excavated soil from the site in one load, and reducing trips by having one mobilization/demobilization for installation of the fencing for all four areas.

    - Ensuring preservation of documented archeological finds by having an archeologist on-site during all of the fencing activities.

- While going through the BMP list on the Step 5 call, the GSR Team suggested some items that the Project Team could consider moving forward. Examples include the following:

    - Including a section on GSR, with the results of this GSR evaluation in some form, in the Final FS.

- The Project Team identified that some BMPs are not practical to implement because of other project-specific constraints. Examples include the following:

    - Purchasing Renewable Energy Certificates (RECs) to offset energy use is not considered to be practical because the site already receives rebates from the local utilities.

    - Exploring multiple site re-use options is not really a possibility, since the overall objective for this project does not include beneficial re-use of the area. With respect to the MEC contamination, it is very difficult to ensure that an area is completely remediated with subsurface clearing. Therefore, even after an area is remediated there will be LUCs.

- Carpooling will not be possible for UXO Technicians, since they would typically come from different places that are a significant distance from the site.

- Generating renewable energy on-site using solar panels would be impractical for several reasons. There are no long-term energy needs for this project, the topography and numerous trees would reduce the amount of sunlight reaching the panels, and the added safety concerns would require specialized construction (which would drive up cost and lengthen the potential payback period).

2.2 QUANTITATIVE FOOTPRINT ANALYSIS FOR MEC ALTERNATIVES AT CTA, LL6, PDS, and INDA

2.2.1 Overview of MEC Alternatives

According to the Draft FS Report (dated November 2011), three alternative responses for MEC contamination are being considered for each of the four MRSs that have been carried forward from the MMRP RI and included in the MMRP FS at IAAAP. The three alternatives are as follows:

- MEC Alternative 1 – No Action
- MEC Alternative 2 – Land Use Controls (recommended for each MRS in the Draft FS)
- MEC Alternative 3 – MEC Subsurface Clearance

Since a "no action" alternative does not have a quantifiable footprint, SiteWise analysis for MEC Alternative 1 will not be conducted for any of the four MRSs. SiteWise analysis has been conducted for both MEC Alternatives 2 and 3 at each MRS.

Overview of MEC Alternative 2

For the purposes of calculating footprints, MEC Alternative 2 involves the following components:

- CTA and LL6
  - Security fencing already in place around the perimeter of these MRSs (no additional fencing needed)
  - Installation of signage every 100 ft along MRS boundaries
  - UXO escort during sign installation
  - Annual O&M, including sign and fence inspection and maintenance (performed by a UXO technician) and mowing along fence line
- PDS and INDA
  - Security fencing and signage already in place around the perimeter of these MRSs (no additional fencing or signage needed)
  - Annual O&M, including sign and fence inspection and maintenance (performed by a UXO technician) and mowing along fence line, is the only activity with a quantifiable footprint for MEC Alternative 2 at the PDS and INDA MRSs

Overview of MEC Alternative 3

For the purposes of calculating footprints, MEC Alternative 3 involves the following components:

- MEC subsurface clearance over the entire MRS - based on the FS, potential MEC items would be removed to a depth of 2 feet using manual removal techniques (e.g., shovels, hand equipment)
- Intrusive investigation
    - DGM reacquisition and dig of 31 acres for CTA and 8 acres for LL6 (two teams, 100 digs per day per team, 1 day for each acre)
    - Analog mag, flag, and dig of 48 acres for PDS and 34 acres for INDA (two teams, 80 digs per day per team, 1.25 days for each acre)
- 2 project personnel, two 7-person UXO teams, and two additional UXO specialists conducting field work for (31 days for CTA, 8 days for LL6, 60 days for PDS, and 42.5 days for INDA)
- Assume approximately 200 anomalies/acre, demilitarization of 40 MD items per acre and one BIP/consolidated shot per 1000 digs

Costs for Alternatives

Cost calculations for the proposed alternatives are based on cost information provided in Appendix A of the Draft FS, which are divided into capital costs, annual O&M costs, and periodic costs incurred every 5 years. To determine net present value (NPV), a 2.3 percent discount rate is applied to future costs, which is consistent with the discount rate applied in the Draft FS. NPV is calculated by discounting future costs to present-day dollars using the following equation:

$$PV = \frac{FV}{(1+i)^n} = C \times FV$$

PV is the present value
FV is the value in year "n" (i.e., future value)
i is the discount rate
C is the discount factor, which equals $1/(1+i)^n$

Information regarding costs for each of the MEC alternatives is presented below. The spreadsheets used by the GSR Team to calculate the discounted costs are included in the Appendix for each MEC alternative (Appendix B-1 to B-8).

	Capital Cost ($ in Year 0)	Annual O&M ($ per yr)	Periodic Cost ($ per 5-yrs)	Life-Cycle Cost ($) (No Discounting)	Life-Cycle Cost ($ NPV) (2.3% Discount Rate)
MEC Alt 2 – CTA	$51,259	$2,975	$3,105	$159,139	$127,971
MEC Alt 3 – CTA	$902,153	$0	$3,105	$920,783	$914,904
MEC Alt 2 – LL6	$45,098	$2,890	$3,105	$150,428	$119,983
MEC Alt 3 – LL6	$332,510	$0	$3,105	$351,140	$345,261
MEC Alt 2 – PDA	$39,675	$5,279	$3,105	$216,675	$165,922
MEC Alt 3 – PDA	$1,399,495	$0	$3,105	$1,418,125	$1,412,246
MEC Alt 2 – INDA	$39,675	$5,256	$3,105	$215,985	$165,427
MEC Alt 3 – INDA	$1,035,939	$0	$3,105	$1,041,818	$1,035,939

2.2.2 Summary of Quantitative Footprint Results

Tables 2-2 to 2-5 summarize the GSR footprint results as follows:

- Table 2-2: MEC Alternatives 2 and 3 (CTA)
- Table 2-3: MEC Alternatives 2 and 3 (LL6)
- Table 2-4: MEC Alternatives 2 and 3 (PDS)
- Table 2-5: MEC Alternatives 2 and 3 (INDA)

Input to the SiteWise tool and other supporting calculations are described in Appendices B-1 to B-8. The SiteWise files utilized for this portion of the analysis are supplied electronically.

Tables 2-2 to 2-5 divide total energy use and global warming potential into "direct" and "indirect" use and emissions. The following definitions are utilized for "direct" versus "indirect" energy use and global warming potential:

- Direct Scope 1: From sources that are owned or controlled by the reporting entity.

- Indirect Scope 2: Due to activities of the reporting entity, but occur at sources owned or controlled by another entity, from consumption of purchased electricity, heat or steam.

- Indirect Scope 3: Due to activities of the reporting entity, but occur at sources owned or controlled by another entity, other than Scope 2 (such as the extraction and production of purchased materials and fuels, transport-related activities in vehicles not owned or controlled by the reporting entity, outsourced activities, waste disposal, etc.

SiteWise reports total energy use and total global warming potential, but does not sum the "direct" and "indirect" components. The user needs to track the distinction between "direct" and "indirect" components separately, based on information contained within the SiteWise spreadsheets. The separation of the total energy and global warming potential is documented in Appendix B, which describes SiteWise input and related calculations.

Table 2-2
Summary of Quantitative Footprint for MEC Alternatives at CTA

GSR Parameter	Unit	MEC Alternative 2 at CTA	MEC Alternative 3 at CTA
Environmental			
Energy – Total	MMBtu	75.2	121.6
Energy – Direct Scope 1	MMBtu	5.8	0
Energy – Indirect Scope 2	MMBtu	0	0
Energy – Indirect Scope 3	MMBtu	69.4	121.6
% of Energy from Renewable Resources	%	0%	0%
Global warming potential – Total	Metric tons CO2e	6.1	9.4
Global warming potential – Direct Scope 1	Metric tons CO2e	0.5	0
Global warming potential – Indirect Scope 2	Metric tons CO2e	0	0
Global warming potential – Indirect Scope 3	Metric tons CO2e	5.6	9.4
Criteria air pollutant emissions	Metric tons (NOx+SOx+PM)	0.0129	0.0168
Hazardous air pollutant emissions	Lb	0	0
Potable water use	1,000s of gallons	0	0
Other water use	1,000s of gallons	0	0
Refined materials use	Lbs	8,125	Minor explosives for BIP
% of refined materials from recycled material	%	0%	0%
Unrefined materials use	Ton	0	0
% of unrefined materials from recycled material	%	0%	0%
Non-hazardous waste generation	Ton	0	0
Hazardous waste generation	Ton	0	0
% of potential waste that is recycled or re-used	%	N/A	N/A
Land transferred or made available for beneficial use	Acres	0	0
Existing ecosystem destruction	Acres	Not quantified	Not quantified
Time frame for land re-use	Years	Not determined	Not determined
Flexibility and breadth of options for re-use*	see below	Not determined	Not determined
Economic			
Life-cycle Cost, Discounted (2.3% discount rate)	$	$127,971	$914,904
Life-cycle Cost, Undiscounted	$	$159,139	$920,783
Up-front Cost	$	$ 51,259	$902,153
Societal			
Predicted number of injuries or fatalities for On-Site Worker	Number of injuries or fatalities	0	0
Predicted number of injuries or fatalities associated with transportation	Number of injuries or fatalities	0.0017	0.0104
One-Way Heavy Vehicle Trips through Res. Area	Trips	None	None

**Scale for flexibility and breadth of re-use options (greater GSR value with lower number, indicating more breadth and flexibility for potential re-use)*

1 - Unlimited re-use options
2 - Limited re-use options
3 - Only one re-use option

Table 2-3
Summary of Quantitative Footprint for MEC Alternatives at LL6

GSR Parameter	Unit	MEC Alternative 2 at LL6	MEC Alternative 3 at LL6
Environmental			
Energy – Total	MMBtu	60.4	88.5
Energy – Direct Scope 1	MMBtu	2.6	0
Energy – Indirect Scope 2	MMBtu	0	0
Energy – Indirect Scope 3	MMBtu	57.8	88.5
% of Energy from Renewable Resources	%	0%	0%
Global warming potential – Total	Metric tons CO2e	4.8	6.7
Global warming potential – Direct Scope 1	Metric tons CO2e	0.2	0
Global warming potential – Indirect Scope 2	Metric tons CO2e	0	0
Global warming potential – Indirect Scope 3	Metric tons CO2e	4.6	6.7
Criteria air pollutant emissions	Metric tons (NOx+SOx+PM)	0.0102	0.0155
Hazardous air pollutant emissions	Lb	0	0
Potable water use	1,000s of gallons	0	0
Other water use	1,000s of gallons	0	0
Refined materials use	Lbs	3,804	Minor explosives for BIP
% of refined materials from recycled material	%	0%	0%
Unrefined materials use	Ton	0	0
% of unrefined materials from recycled material	%	0%	0%
Non-hazardous waste generation	Ton	0	0
Hazardous waste generation	Ton	0	0
% of potential waste that is recycled or re-used	%	N/A	N/A
Land transferred or made available for beneficial use	Acres	0	0
Existing ecosystem destruction	Acres	Not quantified	Not quantified
Time frame for land re-use	Years	Not determined	Not determined
Flexibility and breadth of options for re-use*	see below	Not determined	Not determined
Economic			
Life-cycle Cost, Discounted (2.3% discount rate)	$	$119,983	$345,261
Life-cycle Cost, Undiscounted	$	$150,428	$351,140
Up-front Cost	$	$ 45,098	$332,510
Societal			
Predicted number of injuries or fatalities for On-Site Worker	Number of injuries or fatalities	0	0
Predicted number of injuries or fatalities associated with transportation	Number of injuries or fatalities	0.0017	0.0039
One-Way Heavy Vehicle Trips through Res. Area	Trips	None	None

**Scale for flexibility and breadth of re-use options (greater GSR value with lower number, indicating more breadth and flexibility for potential re-use)*

1 - Unlimited re-use options
2 - Limited re-use options
3 - Only one re-use option

Table 2-4
Summary of Quantitative Footprint for MEC Alternatives at PDS

GSR Parameter	Unit	MEC Alternative 2 at PDS	MEC Alternative 3 at PDS
Environmental			
Energy – Total	MMBtu	49.9	116.6
Energy – Direct Scope 1	MMBtu	9.0	0
Energy – Indirect Scope 2	MMBtu	0	0
Energy – Indirect Scope 3	MMBtu	40.9	116.6
% of Energy from Renewable Resources	%	0%	0%
Global warming potential – Total	Metric tons CO2e	4.0	9.0
Global warming potential – Direct Scope 1	Metric tons CO2e	0.8	0
Global warming potential – Indirect Scope 2	Metric tons CO2e	0	0
Global warming potential – Indirect Scope 3	Metric tons CO2e	3.1	9.0
Criteria air pollutant emissions	Metric tons (NOx+SOx+PM)	0.0150	0.0166
Hazardous air pollutant emissions	Lb	0	0
Potable water use	1,000s of gallons	0	0
Other water use	1,000s of gallons	0	0
Refined materials use	Lbs	0	Minor explosives for BIP
% of refined materials from recycled material	%	0%	0%
Unrefined materials use	Ton	0	0
% of unrefined materials from recycled material	%	0%	0%
Non-hazardous waste generation	Ton	0	0
Hazardous waste generation	Ton	0	0
% of potential waste that is recycled or re-used	%	N/A	N/A
Land transferred or made available for beneficial use	Acres	0	0
Existing ecosystem destruction	Acres	Not quantified	Not quantified
Time frame for land re-use	Years	Not determined	Not determined
Flexibility and breadth of options for re-use*	see below	Not determined	Not determined
Economic			
Life-cycle Cost, Discounted (2.3% discount rate)	$	$165,922	$1,412,246
Life-cycle Cost, Undiscounted	$	$216,675	$1,418,125
Up-front Cost	$	$ 39,675	$1,399,495
Societal			
Predicted number of injuries or fatalities for On-Site Worker	Number of injuries or fatalities	0	0
Predicted number of injuries or fatalities associated with transportation	Number of injuries or fatalities	0.0012	0.0112
One-Way Heavy Vehicle Trips through Res. Area	Trips	None	None

**Scale for flexibility and breadth of re-use options (greater GSR value with lower number, indicating more breadth and flexibility for potential re-use)*

1 - Unlimited re-use options
2 - Limited re-use options
3 - Only one re-use option

Table 2-5
Summary of Quantitative Footprint for MEC Alternatives at INDA

GSR Parameter	Unit	MEC Alternative 2 at INDA	MEC Alternative 3 at INDA
Environmental			
Energy – Total	MMBtu	51.8	105.9
Energy – Direct Scope 1	MMBtu	6.3	0
Energy – Indirect Scope 2	MMBtu	0	0
Energy – Indirect Scope 3	MMBtu	45.4	105.9
% of Energy from Renewable Resources	%	0%	0%
Global warming potential – Total	Metric tons CO2e	4.1	8.1
Global warming potential – Direct Scope 1	Metric tons CO2e	0.6	0
Global warming potential – Indirect Scope 2	Metric tons CO2e	0	0
Global warming potential – Indirect Scope 3	Metric tons CO2e	3.5	8.1
Criteria air pollutant emissions	Metric tons (NOx+SOx+PM)	0.0129	0.0162
Hazardous air pollutant emissions	Lb	0	0
Potable water use	1,000s of gallons	0	0
Other water use	1,000s of gallons	0	0
Refined materials use	Lbs	0	Minor explosives for BIP
% of refined materials from recycled material	%	0%	0%
Unrefined materials use	Ton	0	0
% of unrefined materials from recycled material	%	0%	0%
Non-hazardous waste generation	Ton	0	0
Hazardous waste generation	Ton	0	0
% of potential waste that is recycled or re-used	%	N/A	N/A
Land transferred or made available for beneficial use	Acres	0	0
Existing ecosystem destruction	Acres	Not quantified	Not quantified
Time frame for land re-use	Years	Not determined	Not determined
Flexibility and breadth of options for re-use*	see below	Not determined	Not determined
Economic			
Life-cycle Cost, Discounted (2.7% discount rate)	$	$165,427	$1,035,939
Life-cycle Cost, Undiscounted	$	$215,985	$1,041,818
Up-front Cost	$	$ 39,675	$1,035,939
Societal			
Predicted number of injuries or fatalities for On-Site Worker	Number of injuries or fatalities	0	0
Predicted number of injuries or fatalities associated with transportation	Number of injuries or fatalities	0.0019	0.0086
One-Way Heavy Vehicle Trips through Res. Area	Trips	None	None

**Scale for flexibility and breadth of re-use options (greater GSR value with lower number, indicating more breadth and flexibility for potential re-use)*

1 - Unlimited re-use options
2 - Limited re-use options
3 - Only one re-use option

2.2.3 Key Findings from Quantitative Footprint Analysis, MEC Alternatives

MEC Alternative 2 is the recommended alternative for each of the four MRSs in the Draft FS. Observations and findings based on the quantitative footprinting results from SiteWise regarding MEC Alternative 2 and MEC Alternative 3 include the following:

- Contributors to energy use and greenhouse gas emissions for MEC alternatives are as follows:

	Alt 2 - Energy Use (MMBtu)			
	CTA	LL6	PDS	INDA
Materials Production – Construction	20.4	9.5	0.0	0.0
Transport of Personnel – Construction	3.7	3.7	0.0	0.0
Transport of Equipment – Construction	3.4	3.4	0.0	0.0
Personnel Transport – O&M (30 yrs)	40.5	40.5	38.8	43.9
Fuel for Mowing – O&M (30 yrs)	7.2	3.3	11.1	7.8
Total	**75.2**	**60.4**	**49.9**	**51.8**

	Alt 3 - Energy Use (MMBtu)			
	CTA	LL6	PDS	INDA
Materials Production – MEC Removal	0.0	0.0	0.0	0.0
Transport of Personnel – MEC Removal	121.6	88.5	116.6	105.9
Transport of Equipment – MEC Removal	0.0	0.0	0.0	0.0
Personnel Transport – O&M (30 yrs)	0.0	0.0	0.0	0.0
Fuel for Mowing – O&M (30 yrs)	0.0	0.0	0.0	0.0
Total	**121.6**	**88.5**	**116.6**	**105.9**

	Alt 2 - Greenhouse Gas Emissions (Metric Tons CO2e)			
	CTA	LL6	PDS	INDA
Materials Production – Construction	1.9	0.9	0.0	0.0
Transport of Personnel – Construction	0.3	0.3	0.0	0.0
Transport of Equipment – Construction	0.3	0.2	0.0	0.0
Personnel Transport – O&M (30 yrs)	3.1	3.1	2.9	3.4
Fuel for Mowing – O&M (30 yrs)	0.7	0.3	1.0	0.7
Total	**6.1**	**4.8**	**4.0**	**4.1**

	Alt 3 - Greenhouse Gas Emissions (Metric Tons CO2e)			
	CTA	LL6	PDS	INDA
Materials Production – MEC Removal	0.0	0.0	0.0	0.0
Transport of Personnel – MEC Removal	9.4	6.7	9.0	8.1
Transport of Equipment – MEC Removal	0.0	0.0	0.0	0.0
Personnel Transport – O&M (30 yrs)	0.0	0.0	0.0	0.0
Fuel for Mowing – O&M (30 yrs)	0.0	0.0	0.0	0.0
Total	**9.4**	**6.7**	**9.0**	**8.1**

- The largest contributor of the energy use and greenhouse gas emissions for MEC Alternative 2 is the transportation of personnel associated with 30 years of O&M. For CTA and LL6, the next biggest contributor is for materials associated with signs (steel and concrete), but those materials are not needed for PDS and INDA.

- The only contributor to energy use and greenhouse gas emissions for MEC Alternative 3 is the transport of personnel for the MEC removal.

- For each MRS, the energy use and greenhouse gas emissions are lower for MEC Alternative 2 than for MEC Alternative 3.

- For MEC Alternative 2, most of the energy use and greenhouse gas emissions are “Indirect Scope 3”, and for MEC Alternative 3 all of the energy use and greenhouse gas emissions are “Indirect Scope 3”. This is the result of the predominant contributors associated with off-site fuel use and material production. For MEC Alternative 2, a small amount of energy use and greenhouse gas emissions is “Direct Scope 1”, which is the result of on-site use of fuel for mowing.

- The criteria pollutant emissions are similar for all alternatives, though for each MRS the value is slightly lower for MEC Alternative 2 than MEC Alternative 3. For MEC Alternative 2, the biggest contributors to the criteria pollutants are NOx emissions associated with the O&M phase (transportation of O&M and fuel consumed for mowing). For MEC Alternative 3, the biggest contributors to the criteria pollutants are NOx emissions associated with transport of personnel for MEC removal.

- There is no significant electricity use associated with this project. Thus, it is assumed that 0% of the energy comes from renewables that might be associated with production of grid electricity.

- Refined materials usage is associated with steel and concrete for signs in MEC Alternative 2 at CTA and LL6. There is no other significant refined or unrefined materials use, though a small amount of explosives might be associated with BIP operations for MEC Alternative 3.

- There is no significant waste disposal for any of the MEC alternatives.

- There is no significant water use associated with any of the MEC alternatives.

- The total number of injuries/fatalities calculated by SiteWise is extremely low for all alternatives, and is entirely associated with transportation (i.e., there is no use of equipment except for mowing). For each MRS the risk of injury/fatality is lower for MEC Alternative 2 than MEC Alternative 3.

Note that all of the footprints for all of the MEC alternatives are extremely minor relative to environmental remedies that involve heavy use of motors, heavy equipment, materials, water, etc.

2.2.4 Primary Footprints for which MEC Alternative 2 would be Preferred

The following key footprints would improve in MEC Alternative 2 versus MEC Alternative 3:

- Energy use is lower for MEC Alternative 2 for each MRS

- Greenhouse gas emissions are lower for MEC Alternative 2 for each MRS
- Criteria pollutant emissions are lower for MEC Alternative 2 for each MRS
- Cost is much lower for MEC Alternative 2 for each MRS
- Risk of injury/fatality is lower for MEC Alternative 2 for each MRS

2.2.5 Primary Footprints for which MEC Alternative 3 would be Preferred

The following footprints would improve in MEC Alternative 3 versus MEC Alternative 2:

- There is refined materials use for MEC Alternative 2 associated with steel and concrete for signs at CTA and LL6 that are not needed for Alternative 3 (there might be a minor amount of explosives required for BIP operations for MEC Alternative 3)

2.2.6 Summary of GSR Results for MEC Alternatives

The Draft FS selected MEC Alternative 2 for each MRS, and MEC Alternative 2 is estimated to cost substantially less than MEC Alternative 3 for each MRS. The GSR footprint results indicate that MEC Alternative 2 also has lower footprints for nearly all the GSR parameters other than cost (although some GSR parameters, such as water use and waste disposal, have negligible footprints for both MEC alternatives). Thus, the GSR results are consistent with the recommendation of MEC Alternative 2 at each MRS.

2.3 QUANTITATIVE FOOTPRINT ANALYSIS FOR MC ALTERNATIVES AT PDS

2.3.1 Overview of Alternatives

According to the Draft FS Report (dated November 2011), three alternative responses for MC contamination are being considered for the Possible Demolition Site (PDS). The three alternatives are as follows:

- MC Alternative 1 – No Action
- MC Alternative 2 – Land Use Controls
- MC Alternative 3 – Removal with Off-Site Disposal

MC Alternative 3 is the recommended alternative for the Possible Demolition Site (PDS) MRS in the Draft FS. Since a “no action” alternative does not have a quantifiable footprint, SiteWise analysis for MC Alternative 1 will not be conducted. SiteWise analysis has been conducted for both MC Alternatives 2 and 3 at the PDS MRS.

For the purposes of footprinting, MC Alternative 2 at the PDS MRS will involve the following components:

- Construction of two groundwater monitoring wells and MC lab sample analysis, including one UXO Tech II for anomaly avoidance during intrusive construction activities and one geologist for oversight of drilling activities

- Replacement of each well once over 30 years
- Annual groundwater sampling performed by one geologist and one UXO Tech II

For the purposes of footprinting, MC Alternative 3 at the PDS MRS will involve the following components:

- Removal with off-site disposal of RDX contaminated soil
- Additional soil sampling to further define RDX subsurface soil contamination
- Excavation of 200 BCY of contaminated soil (300 tons), and transport/disposal in an off-site landfill
- Excavated area will be backfilled, re-graded, and restored to previous conditions
- Field personnel include two UXO Tech II, one geologist, and subcontractors for 5 days

Cost calculations for the proposed alternatives are based on cost information provided in Appendix B of the Draft FS, which are divided into capital costs, annual O&M costs, and periodic costs incurred every 5 years. To determine net present value (NPV), a 2.3 percent discount rate is applied to future costs, which is consistent with the discount rate applied in the Draft FS. NPV is calculated by discounting future costs to present-day dollars using the following equation:

$$PV = \frac{FV}{(1+i)^n} = C \times FV$$

PV is the present value
FV is the value in year "n" (i.e., future value)
i is the discount rate
C is the discount factor, which equals $1/(1+i)^n$

Information regarding costs for each of the MC alternatives is presented below.

	Capital Cost ($ in Year 0)	Annual O&M ($ per yr)	Periodic Cost ($ per 5-yrs)	Life-Cycle Cost ($) (No Discounting)	Life-Cycle Cost ($ NPV) (2.3% Discount Rate)
MC Alt 2 – PDS	$175,501	$6,155	$6,210	$397,411	$333,332
MC Alt 3 – PDS	$231,029	$0	$6,210	$268,289	$256,531

The spreadsheets used by the GSR Team to calculate the discounted costs are included in the Appendix for each MC alternative (Appendix C-1 to C-2).

2.3.2 Summary of Quantitative Footprint Results

Table 2-6 summarizes the quantitative footprint results for the two MC alternatives being considered at PDS. Input to the SiteWise tool and other supporting calculations are described in Appendices C-1 and C-2. The SiteWise files utilized for this portion of the analysis are supplied electronically.

Table 2-6
Summary of Quantitative Footprint for MC Alternatives at PDS

GSR Parameter	Unit	MC Alternative 2 at PDS	MC Alternative 3 at PDS
Environmental			
Energy – Total	MMBtu	431.2	56.9
Energy – Direct Scope 1	MMBtu	26.6	2.56
Energy – Indirect Scope 2	MMBtu	0	0
Energy – Indirect Scope 3	MMBtu	404.6	54.3
% of Energy from Renewable Resources	%	0%	0%
Global warming potential – Total	Metric tons CO2e	37.5	5.0
Global warming potential – Direct Scope 1	Metric tons CO2e	2.2	0.1
Global warming potential – Indirect Scope 2	Metric tons CO2e	0	0
Global warming potential – Indirect Scope 3	Metric tons CO2e	35.3	4.8
Criteria air pollutant emissions	Metric tons (NOx+SOx+PM)	0.122	0.009
Hazardous air pollutant emissions	Lb	0	0
Potable water use	1,000s of gallons	0	0
Other water use	1,000s of gallons	0	0
Refined materials use	Lbs	3,721	0
% of refined materials from recycled material	%	0%	0%
Unrefined materials use	Ton	0.9	0**
% of unrefined materials from recycled material	%	0%	0%
Non-hazardous waste generation	Ton	0	300
Hazardous waste generation	Ton	0	0
% of potential waste that is recycled or re-used	%	N/A	N/A
Land transferred or made available for beneficial use	Acres	0	0
Existing ecosystem destruction	Acres	Not quantified	Not quantified
Time frame for land re-use	Years	Not determined	Not determined
Flexibility and breadth of options for re-use*	see below	Not determined	Not determined
Economic			
Life-cycle Cost, Discounted (2.3% discount rate)	$	$333,332	$256,531
Life-cycle Cost, Undiscounted	$	$397,411	$268,289
Up-front Cost	$	$175,501	$231,029
Societal			
Predicted number of injuries or fatalities for On-Site Worker	Number of injuries or fatalities	0.0007	0.0001
Predicted number of injuries or fatalities associated with transportation	Number of injuries or fatalities	0.0098	0.0019
One-Way Heavy Vehicle Trips through Res. Area	Trips	None	None

**Scale for flexibility and breadth of re-use options (greater GSR value with lower number, indicating more breadth and flexibility for potential re-use)*

1 - Unlimited re-use options
2 - Limited re-use options
3 - Only one re-use option

*** fill is from on-site and is not considered to a be "materials use"*

2.3.3 Key Findings from Quantitative Footprint Analysis, MC Alternative 2 at PDS

MEC Alternative 2 is the recommended alternative for each of the four MRSs in the Draft FS. Observations and findings based on the quantitative footprinting results from SiteWise regarding MEC Alternative 2 and MEC Alternative 3 include the following:

- Contributors to energy use and greenhouse gas emissions for MEC alternatives are as follows:

	Energy Use (MMBtu)	
	MC Alt 2 - PDS	MC Alt 3 - PDS
Materials Production – Construction	5.2	0.0
Transport of Personnel – Construction	14.9	17.0
Transport of Equipment – Construction	2.8	14.1
Equipment Use – Construction	16.4	3.1
Residual Handing/Disposal – Construction	0	22.6
Materials Production – O&M	5.5	0.0
Transport of Personnel – O&M	313.7	0.0
Transport of Equipment – O&M	56.3	0.0
Equipment Use – O&M	16.4	0.0
Total	**431.2**	**56.8**

	Greenhouse Gas Emissions (Metric Tons CO2e)	
	MC Alt 2 - PDS	MC Alt 3 - PDS
Materials Production – Construction	0.7	0.0
Transport of Personnel – Construction	1.1	1.3
Transport of Equipment – Construction	0.3	1.8
Equipment Use – Construction	1.4	0.2
Residual Handing/Disposal – Construction	0.0	1.7
Materials Production – O&M	0.8	0.0
Transport of Personnel – O&M	23.8	0.0
Transport of Equipment – O&M	8.0	0.0
Equipment Use – O&M	1.4	0.0
Total	**37.5**	**5.0**

- The largest contributor of the energy use and greenhouse gas emissions for MC Alternative 2 is the transportation of personnel associated with 30 years of O&M (mostly the result of air travel). For MC Alternative 3, the contributors to energy use and greenhouse gas emissions are roughly similar for transportation of personnel, transportation of equipment, and transportation associated with waste associated with construction (i.e., MC removal).

- The energy use and greenhouse gas emissions are lower for MC Alternative 3 than for MC Alternative 2.

- For each MC alternative, most of the energy use and greenhouse gas emissions are “Indirect Scope 3”, because the predominant contributors are associated with off-site fuel use and/or material production. A small amount of energy use and greenhouse gas emissions are “Direct Scope 1”, which is the result of on-site use of fuel for well drilling in MC Alternative 2 and excavator use for MC Alternative 3.

- The criteria pollutant emissions are lower for MC Alternative 3 than for MC Alternative 2. For MC Alternative 2, the biggest contributors to the criteria pollutants are NOx emissions associated with the transport of personnel in the O&M phase (mostly for air travel). For Alternative 3, the biggest contributors to the criteria pollutants are NOx emissions associated with transport of equipment for MEC removal.

- There is no significant electricity use associated with this project. Thus, it is assumed that 0% of the energy comes from renewables that might be associated with production of grid electricity.

- Refined materials usage for MC Alternative 2 is associated with well drilling materials (PVC for well casings, cement for grout, and polyethylene for piping), and unrefined materials usage for MC Alternative 2 is also associated with well drilling materials (sand for filter pack). There is no significant materials usage for MC Alternative 3.

- There is no significant waste disposal for MC Alternative 2, but there is non-hazardous waste disposal for MC Alternative 3 (300 tons).

- There is no significant water use associated with any of the MEC alternatives.

- The total number of injuries/fatalities calculated by SiteWise is extremely low for all alternatives, and is mostly associated with transportation (i.e., with a much smaller risk associated with on-site use of equipment). The risk of injury/fatality is lower for MC Alternative 3 than MC Alternative 2.

Note that all of the footprints for all of the MEC alternatives are extremely minor relative to environmental remedies that involve heavy use of motors, heavy equipment, materials, water, etc.

2.3.4 Primary Footprints for which MC Alternative 2 would be Preferred

The following key footprints would improve in MC Alternative 2 versus MC Alternative 3:

- There is no off-site waste disposal for MC Alternative 2, whereas there is for MC Alternative 3

- The up-front costs are lower for MC Alternative 2 (although life-cycle cost is lower for MC Alternative 3)

2.3.5 Primary Footprints for which MC Alternative 3 would be Preferred

The following footprints would improve in MC Alternative 3 versus MC Alternative 2:

- Energy use is lower for MC Alternative 3

- Greenhouse gas emissions are lower for MC Alternative 3

- Criteria pollutant emissions are lower for MC Alternative 3

- There is no refined or unrefined materials use for MC Alternative 3, whereas there is for MC Alternative 2

- Life-cycle cost is lower for MC Alternative 3

- Risk of injury/fatality is lower for MC Alternative 3

2.3.6 <u>Summary of GSR Results for MC Alternatives</u>

The Draft FS selected MC Alternative 3 for the PDS, and MC Alternative 3 is estimated to cost substantially less over the life-cycle than Alternative 2 (though there is slightly greater up-front cost for MC Alternative 3). The GSR footprint results indicate that Alternative 3 also has lower footprints for nearly all of the GSR parameters other than cost (although some GSR parameters, such as water use, have negligible footprints for both MEC alternatives). Thus, the GSR results are consistent with the recommendation of MC Alternative 3 for the PDS.

2.4 OTHER QUALITATIVE CONSIDERATIONS

None.

3.0 GSR RECOMMENDATIONS

The quantitative GSR footprint results are consistent with the recommended alternatives in the Draft FS (i.e., MEC Alternative 2 and MC Alternative 3). Additionally, the overall footprints for these alternatives are extremely minor, and therefore any recommendations could only reduce the overall footprint by a small amount. Also, review of the BMPs (Appendix A) did not indicate significant GSR-related items that the Project Team was not already considering. Thus, only one recommendation is provided by the GSR Team, listed below.

Table Number	Recommendation
3-1	3.1 - Include a section on GSR, with the results of this GSR evaluation in some form, in the Final FS.

The tracking table format of Table 3-1 allows the implementation status of the recommendation to be updated as the project progresses.

Table 3-1
Tracking Table for Recommendation 3.1

<table>
<tr><td colspan="2" rowspan="2">Recommendation:

3.1 - Include a section on GSR, with the results of this GSR evaluation in some form, in the Final FS.</td><td>Current Date:
4/10/12</td></tr>
<tr><td>Date of Original Recommendation:
4/10/12</td></tr>
<tr><td colspan="3">Basis for Recommendation (Include discussion of cost impacts and value if appropriate):

The GSR Team suggests that future reports (including the Final FS) would benefit from the addition of a section discussing GSR considerations.</td></tr>
<tr><td colspan="3">Resources Conserved:
☐ Hazardous air pollutants ☐ GHG emissions (CO2e) ☐ Energy ☐ Water ☐ Waste
☐ Criteria pollutants ☐ Safety/Community ☐ Materials ☐ Land-use</td></tr>
<tr><td>Qualitative Net Cost Impact Over 5 Years, No Discounting

☐ Cost Increase ☐ Cost Savings
☒ Cost Neutral ☐ N/A</td><td colspan="2">☐ Recommended action otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="3">Attachment(s) to report with footprint assumptions and calculations:

This is a qualitative recommendation, and no footprint evaluation was performed regarding this recommendation.</td></tr>
<tr><td>Implementation Status:

☐ Fully
☐ Partially
☒ Not Yet
☐ Not Planned</td><td colspan="2">Explanation of Status:

This is a new recommendation for the Project Team to consider.</td></tr>
</table>

FIGURES

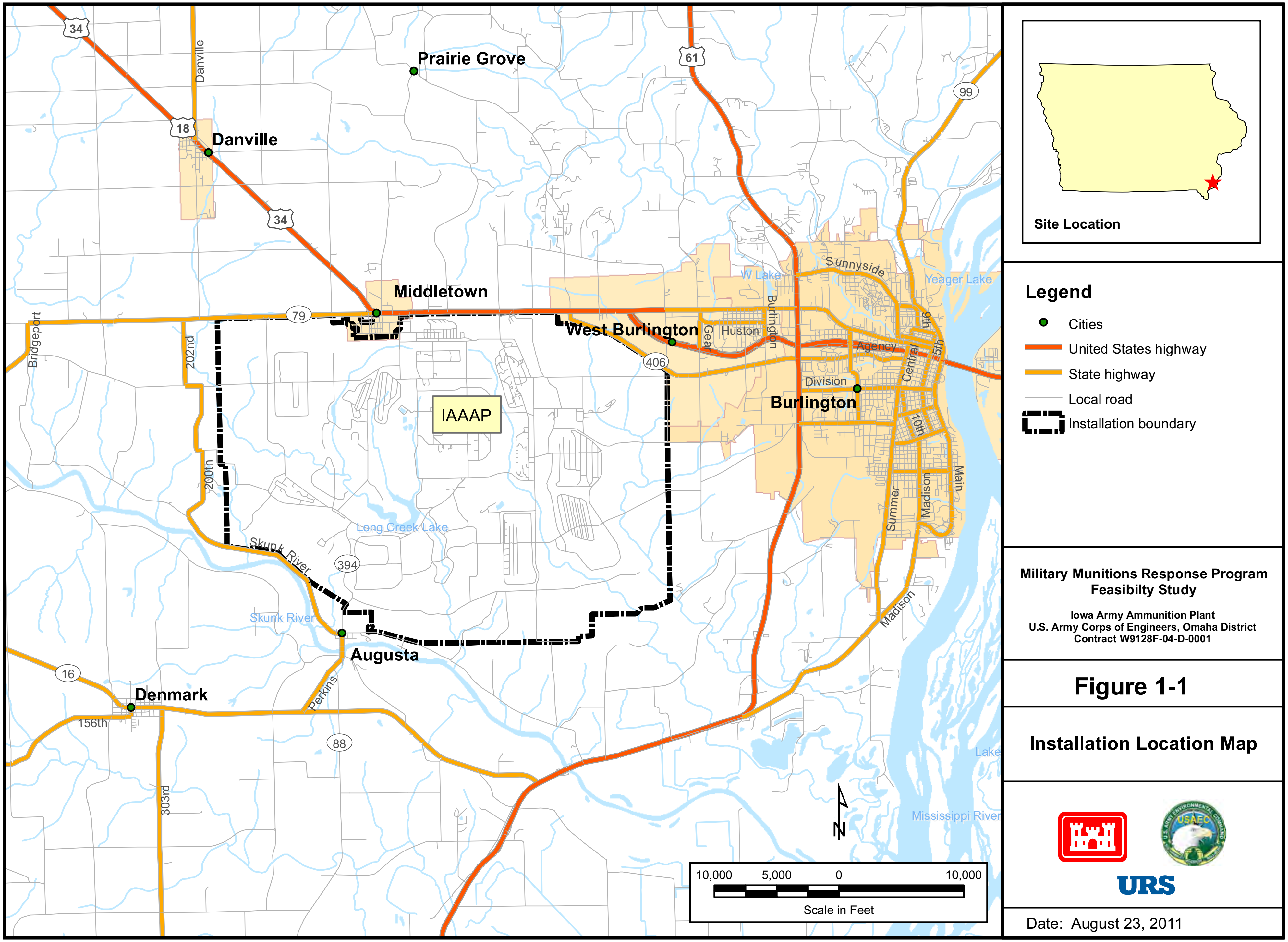

Figure 1-1. Installation Location Map (From Draft FS)

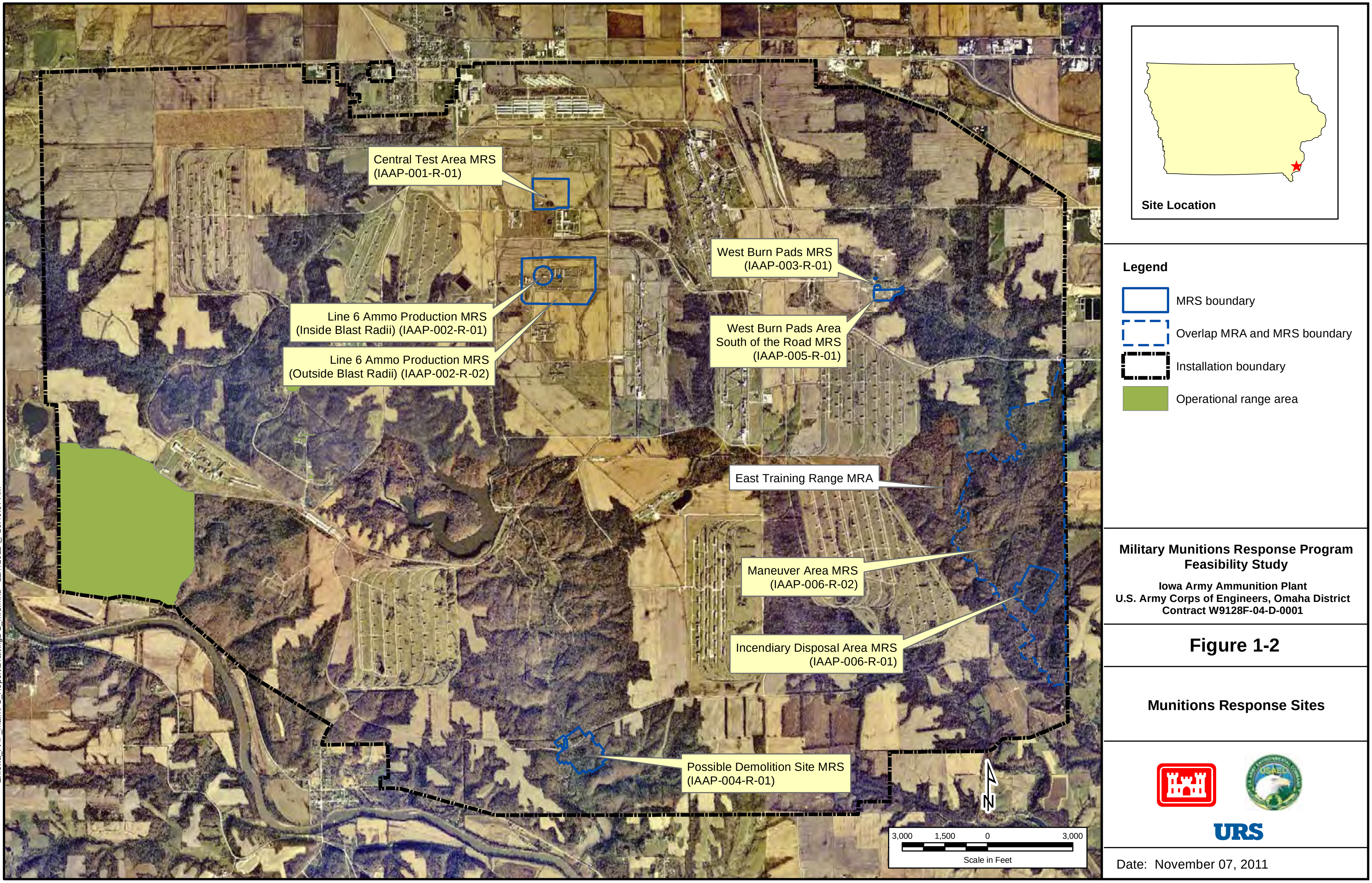

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Figure 1-2. Munitions Response Site (MRS) Boundaries (From Draft FS)

APPENDIX A

Best Management Practice (BMP) Tables

BMP Category A: Planning

BMP A-1: Develop a culture of GSR within the Project Team and encourage GSR ideas from project staff	**Date:** 4/10/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☒ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☒ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *While general best management practices have been applied, GSR considerations have not been specifically evaluated to date.*	

BMP A-2: Incorporate a section on GSR in project meetings, work plans, and reports	**Date:** 4/10/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☒ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *A section on GSR is not currently included in the Draft FS, but the results of this GSR evaluation may be included in some form in the Final FS.*	

BMP A-3: Identify and periodically update a list of key stakeholders and their concerns with respect to GSR considerations

Date: 4/10/12

☒ Applicable

☒ Evaluated

☒ Practical

Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☒ Partially ☐ Not Yet ☐ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

There is an active RAB for this project which is concerned with both off-post and on-post elements of the remedy, but no GSR concerns from the community or regulators have been identified to date.

BMP A-4: Schedule activities for appropriate seasons and/or time of day to reduce delays caused by weather conditions and fuel needed for heating or cooling

Examples:

- Work at night in summer to avoid heat stress
- Perform field activities in summer to take advantage of longer daylight

Date: 4/10/12

☒ Applicable

☒ Evaluated

☒ Practical

Implemented?
("N/A" if "Practical" not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☐ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

The most significant seasonal concern is related to the Indiana Bat; in general, tree removal and the use of heavy equipment are avoided between April 15 and September 15. However, the fencing for LUCs could be installed during this time.

Other seasonal issues in this area may include frozen ground in the winter, which can be worked around, and mud, which can potentially be a problem year-round.

BMP Category A: Planning

BMP A-5: Prepare, store, and distribute documents electronically	**Date:** 4/10/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☒ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☒ Waste ☐ Criteria pollutants ☒ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

The Project Team indicated that many documents are distributed as hard copies, despite the fact that they have requested to send these documents electronically. However, they have successfully moved from three document repositories (each with hard copies) to a website and only one hard copy document repository. The state and AEC are now electronic only, but they have met with resistance to a web-based administrative record. The Project Team also indicated that they are reluctant to keep all or part of documents on CDs because they are worried about being able to retrieve that information in the future (if CDs become obsolete).

BMP A-6: Utilize teleconferences rather than meetings when feasible	**Date:** 4/10/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☐ Waste ☒ Criteria pollutants ☐ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Most of the time, teleconferencing is used rather than meetings with regulators, and meetings are conducted in person only when necessary. The Project Team has made attempts to move to web-based conferencing to further reduce the need for meetings, but the EPA has been resistant.

Attempts are made to schedule meetings around the same time as RAB meetings so that both meetings can be accomplished in one trip.

BMP Category A: Planning

BMP A-7: Incorporate green specifications into solicitations and contracts Examples: - Follow pertinent green procurement policies - Select hotel chains with “green” policies - Select laboratories that utilize renewable energy	**Date:** 4/10/12 ☒ Applicable ☐ Evaluated ☐ Practical
Implemented? (“N/A” if “Practical” not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☒ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *No project-related contracts to date include green specifications.*	

BMP A-8: Integrate schedules to allow for resource sharing and fewer days of field mobilization	**Date:** 4/10/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? (“N/A” if “Practical” not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☐ Waste ☒ Criteria pollutants ☐ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Meetings are often scheduled around RAB meetings so that meeting participants can make only one trip for both.*	

BMP A-9: Explore multiple site reuse options, including those that include some restriction of site reuse and related resource conservation	**Date:** 4/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < \$10,000 ☐ \$10,001 - \$50,000 ☐ \$50,001 - \$100,000 ☐ \$100,001 - \$500,000 ☐ > \$500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Overall, the objective for this project does not include beneficial reuse of the area. With respect to the MEC contamination, it is very difficult to ensure that an area is completely remediated with subsurface clearing. Therefore, even after an area is remediated there will be LUCs.

BMP A-10: Conduct thorough review of project documents and historical records to minimize required scope of investigation Examples: - IRP projects: determine if there are previous aquifer tests that can be used for groundwater modeling rather than conducting new aquifer tests - MMRP projects: perform careful review of historic documents, aerial photographs, and other existing information to reduce the footprint of land that needs to be disturbed for thorough investigation and remediation - MMRP projects: use IRP sampling data to supplement and enhance the MMRP field program (if available)	**Date:** 4/10/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < \$10,000 ☐ \$10,001 - \$50,000 ☐ \$50,001 - \$100,000 ☐ \$100,001 - \$500,000 ☐ > \$500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☒ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Review of historical documents and records is an inherent part of MMRP projects. The Draft FS states that a Historical Records Review was conducted in 2007. Up-front cost considered "negligible" because this is already done as part of an MMRP project.

BMP Category B: Characterization and/or Remedy Approach

BMP B-1: Develop and routinely update a conceptual site model (CSM) to use as a basis for making remedial process decisions	**Date:** 4/10/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☒ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Use of a CSM is an inherent part of MMRP projects. Up-front cost considered "negligible" because this is already done as part of an MMRP project.

BMP B-2: Perform frequent optimization evaluations to improve efficiency of current or planned actions and/or develop alternative remedial approaches that might shorten remedy duration or otherwise improve the net environmental benefit of the remedy	**Date:** 4/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

This BMP is not applicable for this project.

BMP Category B: Characterization and/or Remedy Approach

BMP B-3: Use appropriate characterization or remedy approach based on site conditions Examples: - Consider in-situ and passive remedy options that offer adequate protectiveness - Consider in-situ bioremediation if conditions are already anaerobic and constituents are conducive to reductive dechlorination - Compare source removal versus in-situ and ex-situ remedial options - Consider different technologies for impacted areas with higher and lower concentrations - Use realistic times to remedy closeout (i.e., estimations through modeling) rather than assumed remedy timeframes (e.g., 30 years), which is often used for evaluation of FS alternatives - MMRP projects: evaluate man-portable DGM instruments versus vehicle-towed array (VTA) instruments and inclusion of detector-aided reconnaissance (DAR)	**Date:** 4/10/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *DGM will be utilized in some areas and analog in others due to vegetation levels and slopes.* *The high cost of in-situ treatment for RDX contamination makes such treatment impractical for such a small area. Therefore, LUCs rather than source removal is an appropriate remedy approach for this site.*	

BMP B-4: Establish decision points to trigger a change from one technology to another or from one remedy alternative to another Examples: - Change vapor treatment from thermal oxidation to granular activated carbon (GAC) media based on flow rates and concentrations - Remove a treatment polishing step if influent to that step already meets discharge criteria - Move to Monitored Natural Attenuation (MNA) if specific concentration thresholds in groundwater are met	**Date:** 4/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP is not applicable for this project.*	

BMP Category B: Characterization and/or Remedy Approach

<table>
<tr><td colspan="2">BMP B-5: Focus sampling efforts to meet objectives of the specific remedial phase (e.g., sampling during O&M should be focused on evaluating remedy performance and not on thorough plume characterization)
Examples:
- Eliminate sampling parameters as appropriate
- Reduce sampling frequency as appropriate
- Reduce sample locations as appropriate
- Enhance monitoring program as appropriate
- MMRP projects: consider Incremental Sampling Methodology (ISM) versus discrete sampling for MC characterization</td><td>Date: 4/10/12

☒ Applicable
☐ Evaluated
☐ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A</td><td colspan="2">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☒ Economic ☐ Social</td><td colspan="2">Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td>Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☒ Waste
☐ Criteria pollutants ☒ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Notes (including discussion of possible value of implementing the BMP):

The only sampling will be confirmatory sampling during excavation. During the RI, ISM was used for surface sampling and discrete for subsurface. The sampling method that will be used for confirmatory sampling has not yet been considered, but ISM versus discrete could be evaluated.</td></tr>
</table>

BMP Category B: Characterization and/or Remedy Approach

BMP B-6: Consider real-time measurements and dynamic work plans to reduce mobilizations and improve effectiveness of investigation efforts

Date: 4/10/12

Examples:

- Field test kits (e.g., test kits for sulfate)
- Field screening instruments (e.g., x-ray fluorescence for lead or photoionization detectors for volatile organics)
- Drive point sensor technologies (e.g., membrane interface probe or "MIP")
- Visual staining or odor
- Establish excavation extent based on real-time data collected as excavation proceeds and use GPS to accurately delineate excavation areas
- MMRP projects: use GPS and/or the same equipment that was used for detection to confirm anomaly signatures prior to excavating
- MMRP projects: consider incorporating field screening methods (e.g., X-ray fluorescence, EXPRAY and explosives test kits, as appropriate or applicable) into the field program to refine sampling locations and reduce the quantities of samples submitted for off-site laboratory analysis

☒ Applicable

☒ Evaluated

☒ Practical

Implemented?
("N/A" if "Practical" not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☒ Economic ☒ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☒ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☒ Hazardous air pollutants ☒ Energy ☐ Waste
☒ Criteria pollutants ☐ Materials ☒ Safety/Community
☒ GHG emissions (CO2e) ☐ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Quick turnaround lab analysis will be used for the confirmatory sampling – avoids remobilization.

BMP Category B: Characterization and/or Remedy Approach

<table>
<tr><td colspan="2">BMP B-7: Consider use of existing site structures/infrastructure or mobilization of temporary structures versus new construction
Examples:
- Buildings (e.g., for treatment building or field office)
- Concrete slabs or foundations
- Wells
- Existing excavations for storm water control</td><td>Date: 4/10/12
☒ Applicable
☒ Evaluated
☒ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A</td><td colspan="2">Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☐ Economic ☐ Social</td><td colspan="2">Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td>Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☒ Waste
☐ Criteria pollutants ☒ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Notes (including discussion of possible value of implementing the BMP):

Of the four areas that will be remediated, two (CTA and LL6) already have some form of fencing in place. The existing fencing will likely be utilized to the extent possible, though some upgrades may be needed.</td></tr>
</table>

<table>
<tr><td colspan="2">BMP B-8: Establish project-specific decision points to limit extent of remediation
Examples:
- Project-specific cleanup levels based on a site-specific risk assessment (coordinated with risk assessment experts) rather than generic cleanup levels, if it results in lower footprints for key parameters and is acceptable to all stakeholders
- MMRP projects: dig stopping rules and anomaly prioritization/detection criteria to minimize false positives</td><td>Date: 4/10/12
☒ Applicable
☒ Evaluated
☒ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A</td><td colspan="2">Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☒ Economic ☐ Social</td><td colspan="2">Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td>Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☒ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Notes (including discussion of possible value of implementing the BMP):

A site-specific risk-based goal is being used for excavated soil.</td></tr>
</table>

BMP Category B: Characterization and/or Remedy Approach

<table>
<tr><td colspan="3">BMP B-9: Consider leaving in place structures whose removal is not necessary (i.e., foundations, underground pillars, etc.)</td><td>Date: 4/10/12
☒ Applicable
☒ Evaluated
☒ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☒ Economic ☐ Social</td><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="2">Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☒ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

There are no structures being considered for removal. If the existing fencing is not adequate, the additional fencing would be installed without removing the old.</td></tr>
</table>

BMP Category C: Energy/Emissions – Transportation

BMP C-1: Reduce the number of trips for personnel Examples: - Encourage carpooling - Use telemetry systems and webcams to remotely transmit data directly to project offices to avoid trips	**Date:** 4/10/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☐ Waste ☒ Criteria pollutants ☐ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Personnel needed for soil excavation will likely carpool (2 per car). Only the UXO specialists will be traveling 1 per vehicle (since they will be traveling from different places).

BMP C-2: Reduce the number of trips and/or volume for transported materials, equipment, or waste Examples: - Transfer full loads by consolidating shipments from vendors and/or shipments to disposal sites (also share shipments with neighbors if feasible) - Purchase more concentrated chemicals to reduce transportation weight and/or volume	**Date:** 4/10/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☐ Waste ☒ Criteria pollutants ☐ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

All of the excavated soil will be taken from the site in one load. The fencing for all four areas will start and stop in one mobilization.

BMP Category C: Energy/Emissions – Transportation

BMP C-3: Reduce trip lengths Examples: - Dispose of waste at closest appropriate facility - Purchase materials, equipment, and services from local vendors - Use locally produced supplies - Select most efficient transportation route	**Date:** 4/10/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☐ Waste ☒ Criteria pollutants ☐ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Waste disposal will be within 50 miles of the site. The fencing will come from a local vendor out of Davenport (~89 miles away).

BMP C-4: Use alternate fuels or other options for transportation when possible Examples: - Compressed natural gas - Biodiesel blends - Ethanol blends - Hybrid and/or electric - Rail lines versus trucks - Use a fuel efficient passenger car rather than a pickup truck if task allows	**Date:** 4/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

This BMP is not applicable for this project, which involves minimal transport.

BMP Category D: Energy/Emissions – Equipment Use

BMP D-1: Consider and implement approaches to minimize engine idle times	**Date:** 4/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP is not applicable for this project, which involves very limited equipment use. For the equipment needed to drive the fence posts, there is no practical way to minimize idle time.*	

BMP D-2: Ensure peak operating efficiency of equipment to reduce energy use and emissions Examples: - Perform preventative maintenance and operate equipment per manufacturer instructions - Perform retrofits involving low-maintenance multi-stage filters for cleaner engine exhaust - Use synthetic oil to extend operating life (and reduce waste oil) - Purchase newer equipment with reduced emissions	**Date:** 4/10/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☐ Waste ☒ Criteria pollutants ☐ Materials ☐ Safety/Community ☒ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *It is assumed that this BMP will be implemented by the fencing contractor.*	

BMP Category D: Energy/Emissions – Equipment Use

BMP D-3: Use alternate fuel options for equipment when possible Examples: - Compressed natural gas - Biodiesel - Ethanol blends - Ultra-low sulfur diesel, wherever available (and as required by engines with PM traps)	**Date:** 4/10/12 ☒ Applicable ☒ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Alternate fuels are not likely an option for the fencing contractor.*	

BMP D-4: Select appropriate equipment and/or power source for the job Examples: - Avoid using large excavators for small earthmoving projects - Use direct push methods when possible to reduce drilling duration - Compare potential use of electricity versus battery versus generator	**Date:** 4/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP is not applicable for this project.*	

BMP Category D: Energy/Emissions – Equipment Use

BMP D-5: Use variable frequency drives on motors (e.g., pumps, blowers), or replace oversized motors with properly sized motors	**Date:** 4/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

This BMP is not applicable for this project, since no electrical equipment will be used.

BMP D-6: Identify options for generating renewable energy for direct use in the remedy and/or for alternate use at or near the project site Examples: - Solar, wind, landfill gas (microturbines), combined heat and power, geothermal heat exchange - Applications for remote areas such as solar pumps or solar flares (if demand is not continuous, the need for a battery backup may be avoided) - Generate power or heat exchange from water to be discharged	**Date:** 4/10/12 ☒ Applicable ☒ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

There are no long-term energy needs for this project. Although the areas targeted for remediation will be otherwise unused, there are several constraints that would make solar panels impractical. The topography and numerous trees would reduce the amount of sunlight reaching the panels. In addition, the added safety concerns would require specialized construction, which would drive up cost and lengthen the potential payback period.

BMP Category D: Energy/Emissions – Equipment Use

BMP D-7: Consider purchase of renewable energy certificates to offset emissions from the remedial activities	**Date:** 4/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP is not applicable for this project. There is no long-term energy use, and short-term energy use is minor.*	

BMP D-8: Design/modify housing required for above-ground treatment components for energy-efficiency Examples: - Passive lighting - Compact fluorescent lighting (CFL) or light-emitting diode (LED) lighting - Timers and/or motion control sensors for lighting - Shading - Minimize heating and cooling needs (building size, insulation, etc.)	**Date:** 4/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP is not applicable for this project, since there is no above-ground treatment component.*	

BMP D-9: For remedies that involve groundwater or air extraction, optimize extraction to reduce flow rates (potentially beneficial with respect to energy use, materials usage, water resources, waste disposal, etc.)		**Date:** 4/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A	
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000	
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:	
Notes (including discussion of possible value of implementing the BMP): *This BMP is not applicable for this project.*		

BMP D-10: Consider pulsing for extraction of water or air to maximize mass removal per unit of time or energy, by extracting higher concentrations		**Date:** 4/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A	
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000	
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:	
Notes (including discussion of possible value of implementing the BMP): *This BMP is not applicable for this project.*		

BMP Category D: Energy/Emissions – Equipment Use

BMP D-11: Run electrical equipment during times of lower electric demand if possible (this does not reduce energy use but could lower cost and also can lower stress on the energy grid during periods of peak demand)	**Date:** 4/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

This BMP is not applicable for this project.

BMP Category E: Materials & Off-Site Services

BMP E-1: Use materials that are made from recycled materials Examples: - Steel - Asphalt - Plastics - Concrete	**Date:** 4/10/12 ☒ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☒ Waste ☐ Criteria pollutants ☒ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *The Project Team mentioned that some galvanized fencing will likely be installed prior to the remedial action described in the Draft FS. The Project Team could ask the vendor if it is possible to use recycled fencing material. It may also be possible to use fencing taken from elsewhere. This has not really been evaluated yet.*	

BMP E-2: Optimize the amount of materials used Examples: - Experiment with different material amounts/doses - Consider alternate materials - Use timers or feedback loops and process controls for dosing - MMRP projects: minimize quantities of donor explosives for MEC destruction	**Date:** 4/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP is not applicable for this project.*	

BMP Category E: Materials & Off-Site Services

BMP E-3: Utilize less refined materials when feasible Examples: - Limestone instead of sodium hydroxide for pH adjustment - Native fill instead of select fill	**Date:** 4/10/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☒ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Borrow from on-site will be used for backfill.

BMP E-4: Identify opportunities for using by-products or "waste" materials from local sources in place of refined chemicals or materials Examples: - Cheese whey, molasses, compost, or off-spec food products for inducing anaerobic conditions - Crushed concrete for use as fill - Concrete from coal combustion byproducts	**Date:** 4/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

This BMP is not applicable for this project.

BMP Category E: Materials & Off-Site Services

<table>
<tr><td colspan="3">BMP E-5: Reduce demand on Publicly Owned Treatment Works (POTWs)
Examples:
- Discharge treated water to groundwater or to surface water rather than POTW
- Minimize amount of water requiring treatment</td><td>Date: 4/10/12
☐ Applicable
☐ Evaluated
☐ Practical</td></tr>
<tr><td>Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social</td><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="2">Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

This BMP is not applicable for this project.</td></tr>
</table>

BMP Category F: Water Resource Use

BMP F-1: Minimize water consumption Examples: - Sensors to turn off water when not needed - Low flow fittings - Minimize water needs for irrigation (landscape choices, use of mats and mulch)	**Date:** 4/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

This BMP is not applicable for this project.

BMP F-2: Preferentially use less refined water resources when feasible Examples: - Use extracted groundwater instead of potable water for chemical blending - Capture and store rain/storm water for future use - Employ rumble grates with a closed-loop gray-water washing system	**Date:** 4/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

This BMP is not applicable for this project.

BMP Category F: Water Resource Use

BMP F-3: Use extracted and treated water for beneficial purposes Examples: - Irrigation - Potable water - Industrial process water	**Date:** 4/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP is not applicable for this project.*	

BMP F-4: Promote groundwater recharge Examples: - Recharge extracted and treated water when beneficial uses of the water are not identified and reinjection is practical - Minimize site area covered by impervious surfaces to reduce runoff and maximize infiltration (unless such capping is a specific component of the remedial action)	**Date:** 4/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP is not applicable for this project.*	

BMP Category F: Water Resource Use

<table>
<tr><td colspan="3">BMP F-5: Maintain water quality by preventing nutrient loading to surface water or groundwater
Examples:
- Use phosphate-free detergents instead of organic solvents or acids to decontaminate sampling equipment (if not required for some contaminants)</td><td>Date: 4/10/12
☒ Applicable
☒ Evaluated
☒ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☐ Economic ☐ Social</td><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="2">Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☒ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

For decontamination of excavation equipment, environmentally friendly products are used to the extent possible.</td></tr>
</table>

BMP Category G: Waste Generation, Disposal, and Recycling

BMP G-1: Minimize drill cuttings and all other investigation derived waste (including personal protection equipment) Examples: - Direct push or sonic drilling to reduce drill cuttings - Low-flow sampling or passive diffusion bags (if applicable) to reduce purge water - When possible place drill cuttings on-site rather than off-site disposal	**Date:** 4/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP is not applicable for this project because there will be no investigation derived waste for this phase of remediation.*	

BMP G-2: Segregate excavated soil in pre-planned staging areas so that "clean" material can be deposited on-site and/or reused rather than transported for off-site disposal	**Date:** 4/10/12 ☒ Applicable ☒ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☒ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *The area to be excavated (~200 cubic yards) is too small for segregation to be beneficial. Also, theoretically there will be no "clean soil" in the excavated material.*	

BMP Category G: Waste Generation, Disposal, and Recycling

BMP G-3: Consider on-site treatment and re-use of soil instead of off-site disposal

Examples:

- Land farming
- Above ground soil vapor extraction (SVE)

Date: 4/10/12

☒ Applicable

☒ Evaluated

☐ Practical

Implemented? ("N/A" if "Practical" not checked): ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☒ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use

☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

On-site in-situ or ex-situ treatment are not feasible from a cost perspective given the small area to be remediated.

BMP G-4: Minimize need to transport and dispose hazardous waste

Examples:

- Consider delisting listed hazardous waste if waste is not characteristically hazardous waste
- Segregate hazardous waste and non-hazardous waste

Date: 4/10/12

☐ Applicable

☐ Evaluated

☐ Practical

Implemented? ("N/A" if "Practical" not checked): ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use

☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

The RDX contaminated soil is considered "special waste" (not hazardous) and will be disposed of in a subtitle D landfill as solid waste. Since this waste will not be considered hazardous, this BMP is not applicable.

BMP Category G: Waste Generation, Disposal, and Recycling

BMP G-5: When possible avoid/minimize use of hazardous/toxic materials that may require special handling or disposal Examples: - Cleaning solutions - Pesticides - Disposable batteries (use rechargeable batteries) - MMRP projects: minimize Chemical Agent Contaminated Media (CACM) at RCWM sites.	**Date:** 4/10/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☒ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Water will be used for decon; no use of toxic materials is anticipated.*	

BMP G-6: Recycle or reuse materials rather than disposing of them Examples: - Cardboard - Plastics - Concrete - Asphalt - Steel and other metals - Recovered oil/product - Mulch/compost - MMRP projects - recycle recovered Material Documented as Safe (MDAS) after inspection and certification that the remnants are free of explosive hazards	**Date:** 4/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP is not applicable for this project, since no materials will require disposal (other than the excavated soil).*	

BMP Category H: Land Use, Ecosystems, and Cultural Resources

BMP H-1: Minimize erosion and soil transport to surface water bodies
Examples:
- Quickly restore any vegetated areas disrupted by equipment or vehicles
- Institute appropriate erosion controls during excavation such as silt fencing

Date: 4/10/12
[x] Applicable
[x] Evaluated
[x] Practical

Implemented?
("N/A" if "Practical" not checked)
[x] Fully [ ] Partially [ ] Not Yet [ ] N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
[ ] Cost Increase [ ] Cost Savings [x] Cost Neutral [ ] N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
[x] Environmental [ ] Economic [ ] Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
[x] Negligible [ ] < $10,000 [ ] $10,001 - $50,000
[ ] $50,001 - $100,000 [ ] $100,001 - $500,000 [ ] > $500,000

Resources Conserved:
[ ] Hazardous air pollutants [ ] Energy [ ] Waste
[ ] Criteria pollutants [ ] Materials [ ] Safety/Community
[ ] GHG emissions (CO2e) [x] Water [ ] Land-use

[ ] BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

The design will include a sediment erosion control plan, since nearby surface water could be impacted if appropriate measures are not taken.

BMP H-2: Minimize disturbances to land
Examples:
- Establish well-defined traffic patterns for onsite activities to minimize disturbed areas
- Consider non-intrusive investigation techniques (e.g., geophysical methods) to identify items like USTs and buried drums

Date: 4/10/12
[x] Applicable
[x] Evaluated
[x] Practical

Implemented?
("N/A" if "Practical" not checked)
[x] Fully [ ] Partially [ ] Not Yet [ ] N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
[ ] Cost Increase [ ] Cost Savings [x] Cost Neutral [ ] N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
[x] Environmental [ ] Economic [ ] Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
[x] Negligible [ ] < $10,000 [ ] $10,001 - $50,000
[ ] $50,001 - $100,000 [ ] $100,001 - $500,000 [ ] > $500,000

Resources Conserved:
[ ] Hazardous air pollutants [ ] Energy [ ] Waste
[ ] Criteria pollutants [ ] Materials [ ] Safety/Community
[ ] GHG emissions (CO2e) [ ] Water [x] Land-use

[ ] BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

The Project Team will make an effort to do the minimal amount of vegetation clearing necessary in order to keep the area as undisturbed as possible. This will preserve habitat area for the Indiana Bat and other wildlife.

BMP H-3: Preserve/restore ecosystems to the extent possible Examples: - Limit the removal of trees and vegetation - Attempt to transplant disturbed shrubs and small trees to other locations - Use native species for re-vegetation - Retrieve dead trees during excavation and later reposition them as habitat snags - Select and place suitably sized and typed stones into water beds and banks - Undercut surface water banks in ways that mirror natural conditions - Cut back rather than remove trees, bushes, vegetation	**Date:** 4/10/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☒ Land-use	☒ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *See notes for BMP H-2 above. Implementation of this BMP is driven primarily by an ARAR.*	

BMP H-4: Minimize drawdown of the water table in sensitive areas such as wetlands or areas subject to subsidence	**Date:** 4/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP is not applicable for this project.*	

BMP Category H: Land Use, Ecosystems, and Cultural Resources

BMP H-5: Construct wells and other remedial process infrastructure (piping, buildings, etc.) to minimize restrictions to anticipated future use of the site	**Date:** 4/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP is not applicable for this project.*	

BMP H-6: Preserve/restore cultural resources to the extent possible Examples: - Protected lands such as wildlife refuges, national parks, and wilderness areas - Culturally sensitive sites such as cemeteries, native burials, and archaeological finds - Buildings or land parcels with historical significance	**Date:** 4/10/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *See notes for BMP H-2 and BMP H-3. The site also includes documented archaeological finds, which will be properly protected during remedy activities.*	

BMP Category H: Land Use, Ecosystems, and Cultural Resources

<table>
<tr><td colspan="3">BMP H-7: Document sensitive ecological and cultural resources prior to initiating actions that might diminish or destroy those resources
Examples:
- Photodocument conditions prior to clearing brush
- MMRP projects: photodocument conditions prior to BIP</td><td>Date: 4/10/12
☒ Applicable
☒ Evaluated
☒ Practical</td></tr>
<tr><td>Implemented?
("N/A" if "Practical" not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☐ Economic ☐ Social</td><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="2">Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

An archeologist will be on-site during all of the fencing activities to ensure that any archeological finds in the area are preserved.</td></tr>
</table>

BMP Category I: Safety and Community

BMP I-1: Minimize and mitigate noise, light and odor disturbance during all phases of the remedial process, to the extent practicable	**Date:** 4/10/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☒ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Residences and sensitive receptors (including hospice care and nursing homes) exist within 1 mile of the site. Installation of fencing is not expected to be an issue, but BIP events may be. Notices will be sent out prior to such events.

BMP I-2: Minimize dust during construction activities by spraying water or techniques such as laying biodegradable mats, tarps, or materials (already in EM385-1-1)	**Date:** 4/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Due to the small size of the area, dust is not expected to be an issue. However, a water truck could be used for dust suppression if necessary.

BMP Category I: Safety and Community

BMP I-3: Select transportation routes for trucks and heavy equipment that minimize impacts to residential areas to maximize safety and minimize noise and other aesthetic impacts	**Date:** 4/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Access to the site does not require any trips through residential areas.*	

BMP I-4: Minimize drawdown of the water table in areas that could impact production rates at supply wells and/or irrigation wells	**Date:** 4/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP is not applicable for this project.*	

BMP Category I: Safety and Community

BMP I-5: Minimize amount of time that heavy machinery is needed to enhance safety	**Date:** 4/10/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☒ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP will be likely be implemented because it corresponds with cost reduction.*	

BMP I-6: Minimize handling of dangerous chemicals by selecting alternate chemicals and/or engineering to minimize contact with chemicals (for MMRP projects, there is enhanced risk related to explosion potential and exposure to chemical agents (CA) and agent breakdown products (ABP) associated with RCWM responses)	**Date:** 4/10/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☒ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Minimizing safety risks is an inherent part of MMRP projects.*	

BMP Category I: Safety and Community

BMP I-7: Contribute to local economy when possible Examples: - Consider leasing local office space - Purchase or lease equipment from local vendors - Hire workers from local community	**Date:** 4/10/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☒ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

A local contractor will be used for installation of the fencing, materials will be purchased locally, and field personnel will stay in local hotels.

BMP Category J: Other Site-Specific BMPs

BMP J-1:	**Date:** 4/10/12 ☐ Applicable ☐ Evaluated ☐ Practical

Implemented? (“N/A” if “Practical” not checked) ☐ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

BMP J-2:	**Date:** 4/10/12 ☐ Applicable ☐ Evaluated ☐ Practical

Implemented? (“N/A” if “Practical” not checked) ☐ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

APPENDIX B

Assumptions for SiteWise Input and Other Calculations, Iowa Army Ammunition Plant (MEC Alternatives):

APPENDIX B-1:

MEC Alternative 2 at the Central Test Area MRS

Appendix B-1
Assumptions for SiteWise Input and Other Calculations
Iowa Army Ammunition Plant GSR Evaluation:
MEC Alternative 2 at the Central Test Area MRS

SiteWise "RA_MEC 2 CTA_NoFR_1" Directory

Appendix B-1 of this report includes notes for the footprinting of MEC Alternative 2 at the Central Test Area (CTA) MRS. For the purposes of footprinting, this alternative will involve the following components:

- Security fencing already in place around perimeter of the MRS (no additional fencing needed)
- Installation of signage every 100 ft along MRS boundary
- UXO escort during sign installation
- Annual O&M, including mowing along fence line and sign and fence inspection and maintenance

Unless otherwise noted, SiteWise inputs are based on the information described in Appendix A and the report text of the *Draft Feasibility Study (FS) Report* (dated November 2011). When information required for SiteWise input was not provided, reasonable assumptions were made (these assumptions are noted in the description of SiteWise input below).

The notes pertaining to SiteWise input are organized by the following tabs of the SiteWise input sheet:

- Installation of Engineering Controls – Uses *"Remedial Action Construction"* tab of SiteWise input sheet
- Annual O&M – Uses *"Remedial Action Operations"* tab of SiteWise input sheet

For each section of SiteWise, all the sections are listed, with pertinent information added only for those sections of the input sheet where data were added.

In some cases, small quantities of materials were not included in SiteWise input because the footprint of these items relative to the other materials used would be expected to be extremely minimal.

Other calculations done outside of SiteWise are then presented. These include the following:

- % of total energy from renewable resources
- Hazardous air pollutants
- Refined material use
- Unrefined material use
- Tons of non-hazardous waste
- Tons of hazardous waste
- % of Potential Waste Recycled
- Risks to on-site works and from transportation

- Heavy truck trips through residential areas

Additional tables are attached which show how SiteWise outputs were split into "direct" and "indirect" energy use and greenhouse gas emissions. For definitions of direct and indirect energy use and emissions, please refer to section 2.2.2 of the evaluation report.

Cost calculations are based on cost information provided in Appendix A of the Draft FS. A summary cost sheet developed by the GSR Team is attached to this Appendix. Information regarding the cost calculations is as follows:

- The capital cost is \$51,259 and occurs in year 0.

- The annual O&M cost is \$2,975, occurring each year in years 1 through 30.

- The periodic cost is \$3,105, occurring every five years in years 5, 10, 15, 20, 25, and 30.

- The sum of capital, annual, and periodic costs, non-discounted, is \$159,139.

- To determine net present value (NPV), a 2.3 percent discount rate is applied to future costs, which is consistent with the discount rate applied in the Draft FS. NPV is calculated by discounting future costs to present-day dollars using the following equation:

$$PV = \frac{FV}{(1+i)^n} = C \times FV$$

PV is the present value
FV is the value in year "n" (i.e., future value)
i is the discount rate
C is the discount factor, which equals $1/(1+i)^n$

- The NPV calculated by the GSR Team is \$127,971.

MEC Alternative 2 at CTA – Installation of Engineering Controls

Scope of Work

Appendix A of the Draft FS indicates that signs will be installed every 100 ft for 4,713 ft along the CTA MRS boundary at a production rate of 1,500 ft per hr. 4,713 ft / 1,500 ft per hour = 3.14 hours total.

It is assumed that signage installation for MEC Alternative 2 at CTA and LL6 will be completed with one mobilization (the Draft FS text indicates that fencing and signage will be in place at PDS and INDA by the time the FS is finalized, and are therefore not included). To account for this, SiteWise inputs related to mob/demob for installation of engineering controls for MEC Alternative 2 at these two MRSs are divided by 2.

Appendix A of the Draft FS indicates that the necessary materials include signs (47 total for CTA), steel posts (galvanized, 10' upright, GSR Team assumes one per sign), and normal weight concrete (ready mix). Weights and quantities of these materials are not further specified; the GSR Team makes the assumptions indicated below in the SiteWise inputs section.

Appendix A of the Draft FS indicates that one UXO Tech II will be needed for anomaly avoidance during sign installation. Based on information provided by the Project Team on the Step 5 call which took place on 11/21/11, UXO technicians will be travelling alone (i.e., no carpooling) and will travel 8 hours one-way to the site via a combination of air and car. The GSR Team assumes that this will equate to approximately 100 miles via car and 700 miles via plane. It is further assumed that the UXO Tech will be staying in a nearby hotel in Burlington, IA (~12 miles round trip to site and back) for two nights.

The Project Team indicated on the Step 5 call that a local vendor out of Davenport (~89 miles one-way) will be used for the fencing, and the GSR Team assumes that this same vendor will be used for signage. The GSR Team assumes that two workers from this local contractor will be needed to drive the steel posts and install signs. Since installation of signage for both the CTA and LL6 should take less than one day total and the contractor is within reasonable driving distance of the site, it is assumed that the workers will not be staying overnight in a hotel.

MEC Alternative 2 at CTA – Installation of Engineering Controls

<u>Input into "Remedial Action Construction" tab of SiteWise Input Sheet.xls</u>

- Baseline Information
  - Remedial Action Construction Cost
    - Total remedial action construction cost ($) – leave blank in SiteWise

- Material Production
  - Well Materials
  - Treatment Chemicals & Materials
  - Treatment Media
  - Construction Materials
  - Well Decommissioning
  - Bulk Material Quantities
    - Material 1 – Signs. Select steel to represent galvanized steel (assumed) and units of cubic feet. Assume each sign is roughly 0.05" thick * 24" tall * 24" wide = 28.8 cubic inches / 1728 cubic inches per cubic foot = 0.016667 cubic feet per sign * 47 signs = 0.783333 cubic feet total.
    - Material 2 – Steel posts. Select steel to represent galvanized steel and units of cubic feet. Each post will be 10 feet tall, and assume roughly 0.25" thick * 2" wide. 120" * 0.25" * 2" = 60 cubic inches / 1728 cubic inches per cubic foot = 0.034722 cubic feet per post * 47 posts = 1.631944 cubic feet total.
    - Material 3 – Normal weight concrete. Select general concrete and units of cubic feet. Assume a 1 cubic foot block of concrete per sign. 1 cubic foot per sign * 47 signs = 47 cubic feet total.

- Transportation
  - Personnel Transportation – Road
    - Trip 1 – UXO Tech, car travel to and from site. Assume a car, gasoline. 100 miles one-way * 2 = 200 miles round trip / 2 (accounting for shared mobilization with LL6 MRS) = 100 miles, 1 trip, 1 traveler.
    - Trip 2 – UXO Tech, daily car travel from hotel to site. Assume a car, gasoline. 12 miles round trip / 2 (accounting for shared mobilization with LL6 MRS) = 6 miles, 1 trip (for one day of field work at site), 1 traveler.
    - Trip 3 – Contractor for signage. Assume light trucks, gasoline. 89 miles one-way * 2 = 178 miles round trip / 2 (accounting for shared mobilization with LL6 MRS) = 89 miles, 2 trip (assuming two separate trucks needed to transport materials), 1 traveler per truck.
  - Personnel Transportation – Air
    - Trip 1 – UXO Tech, plane travel to and from site. 700 miles one-way * 2 = 1400 miles round trip / 2 (accounting for shared mobilization with LL6 MRS) = 700 miles, 1 traveler, 1 flight.
  - Personnel Transportation – Rail
  - Equipment Transportation – Road
    - Trip 1 – Transport of all sign materials to site. Assuming these materials will be brought to site with contractor, select gasoline and 89 miles one way * 2 trucks = 178 miles. (Do not need to account for shared mobilization with LL6 MRS here, since transport of sign materials for LL6 will be included separately in the SiteWise input for that MRS. The equipment transport footprints for CTA and

LL6 will be slightly different due to the difference in weight of the materials.) Estimated total weight (from SiteWise output sheet) = 174.3 kg (steel signs) + 363.2 kg (steel posts) + 3155.5 kg (concrete) = 3693.0 kg / 907.18 kg per ton = 4.1 tons / 2 trucks = 2.05 tons per truck. Since fuel use for contractor return trips is already accounted for in Personnel Transportation Trip 3 above, no empty return trips are included here.

  - Equipment Transportation – Air
  - Equipment Transportation – Rail
  - Equipment Transportation – Water

- Equipment Use
  - Earthwork
  - Drilling
  - Trenching
  - Pump Operation
  - Diesel and Gasoline Pumps
  - Blower, Compressor, Mixer, and Other Equipment
  - Generators
  - Agricultural Equipment
  - Capping Equipment
  - Mixing Equipment
  - Internal Combustion Engines
  - Other Fueled Equipment
  - Operator Labor
  - Laboratory Analysis
  - Other Known Onsite Activities

- Residual Handling
  - Residue Disposal/Recycling
  - Landfill Operations
  - Thermal/Catalytic Oxidizers

- Resource Consumption
  - Water Consumption
  - Onsite Land and Water Resource Consumption

Once SiteWise input is complete, go to "SiteWise_Input Sheet" for overall project and enter information (including Alternative File Name "MEC 2 CTA"). Then go to "Generate Alternative" tab and click button labeled "Click to generate alternative using previously entered alternative name". Copies of the input and output summary sheets for this alternative are now located in the directory titled "RA_MEC 2 CTA_NoFR_1". To store the "Remedial Action Construction.xls" calculation sheet showing detailed calculations, open it in the overall SiteWise project directory when the appropriate input sheet is open, then do a "save as" to put it in the directory for this alternative using a name that indicates "will not update". Then open that file and do "data->edit links" and break the links. If the input sheet for this alternative ever changes, then this calculation sheet needs to be re-saved.

MEC Alternative 2 at CTA – Installation of Engineering Controls

To edit input parameters for this alternative, you must go back to the ORIGINAL SiteWise input sheet and import this alternative using the "Do you want to reload a previously saved remedial alternative in the SiteWise input sheet?" field on the "Site Info" tab. After making necessary changes to the input sheet, re-export the alternative by going to the "Generate Alternative" tab and clicking the button labeled "Click to replace an existing alternative with the same name". Update saved calculation sheets as described above.

MEC Alternative 2 at CTA – Annual O&M

<u>Scope of Work</u>

Appendix A of the Draft FS indicates that one UXO Tech II will be needed for annual sign and fence inspection and maintenance. Based on information provided by the Project Team on the Step 5 call which took place on 11/21/11, UXO technicians will be travelling alone (i.e., no carpooling) and will travel 8 hours one-way to the site via a combination of air and car. The GSR Team assumes that this will equate to approximately 100 miles via car and 700 miles via plane per year for 30 years of O&M.

The cost information in Appendix A of the Draft FS indicates that a UXO Tech II will be needed for the following number of hours at each MRS (per year):

- CTA – 20 hrs
- LL6 – 20 hrs
- PDS – 10 hrs
- INDA – 40 hrs

Assuming that one UXO Tech will be utilized to inspect the signs and fences at all MRSs during a single trip to the site each year, the SiteWise inputs associated with travel to the local are for each MEC Alternative 2 at these four MRSs are divided by 4. Trips from the hotel to the site and back are assigned based on the number of hours spent at each MRS listed above, assuming 10 hour days. For CTA, this means two 12-mile round trips from the hotel to the site (one per day).

Appendix A of the Draft FS indicates that mowing will be required in the 10 ft^2 along 4,713 LF of the MRS fence line. The GSR Team assumes ~0.5 hours per acre * 1.1 acres to be mowed * mowing 2 times per year = 1.1 hours per year to mow area around CTA fence with large riding mower, such as those found at: http://www.deere.com/wps/dcom/en_US/products/equipment/front_mowers/front_mowers.page. The website indicates that the majority of these mowers run on diesel, and that each has a 16 gallon fuel tank that allows for 10 hours of runtime without refueling. Based on this statement, it is estimated that a mower of this size would have a consumption rate of 1.6 gallons per hour (16 gallons / 10 hours).

It is assumed that mowing at all 4 MRSs will be completed as a part of regular installation maintenance, and therefore a separate mob/demob for personnel is not included in the footprint for each MRS. It is also assumed that the mower is already owned and maintained by the installation, and mob/demob for the mower is not part of the footprint for each MRS. The footprint associated with mowing is therefore comprised only of the fuel usage required for mowing the specified area.

MEC Alternative 2 at CTA – Annual O&M

<u>Input into "Remedial Action Operations" tab of SiteWise Input Sheet.xls</u>

- Baseline Information
  - Remedial Action Operations Cost and Duration
    - Total remedial action operations cost ($) – leave blank in SiteWise
    - Duration of remedial action operations (unit time) – 1 yr for this GSR evaluation because we have multiplied input items by number of years as part of the input

- Material Production
  - Well Materials
  - Treatment Chemicals & Materials
  - Treatment Media
  - Construction Materials
  - Well Decommissioning
  - Bulk Material Quantities

- Transportation
  - Personnel Transportation – Road
    - Trip 1 – UXO Tech, car travel to and from site. Assume a car, gasoline. 100 miles one-way * 2 = 200 miles round trip / 4 (accounting for shared mobilization with other MRSs) = 50 miles, 1 trip per year for 30 years = 30 trips, 1 traveler.
    - Trip 2 – UXO Tech, daily car travel from hotel to site. Assume a car, gasoline. 12 miles round trip, 2 trips (for 2 days of field work at site, assuming 10 hour days) per year for 30 years = 60 trips, 1 traveler.
  - Personnel Transportation – Air
    - Trip 1 – UXO Tech, plane travel to and from site. 700 miles one-way * 2 = 1400 miles round trip / 4 (accounting for shared mobilization with other MRSs) = 350 miles, 1 traveler, 1 flight per year for 30 years = 30 flights.
  - Personnel Transportation – Rail
  - Equipment Transportation – Road
  - Equipment Transportation – Air
  - Equipment Transportation – Rail
  - Equipment Transportation – Water

- Equipment Use
  - Earthwork
  - Drilling
  - Trenching
  - Pump Operation
  - Diesel and Gasoline Pumps
  - Blower, Compressor, Mixer, and Other Equipment
  - Generators
  - Agricultural Equipment
  - Capping Equipment
  - Mixing Equipment
  - Internal Combustion Engines

        - Engine 1 – Large riding mower for mowing along MRS fence line. Assume diesel, fuel consumption rate of 1.6 gal/hr, 1.1 hours of operation per year * 30 years = 33 hours.
    - Other Fueled Equipment
    - Operator Labor
    - Laboratory Analysis
    - Other Known Onsite Activities

- Residual Handling
    - Residue Disposal/Recycling
    - Landfill Operations
    - Thermal/Catalytic Oxidizers

- Resource Consumption
    - Water Consumption
    - Onsite Land and Water Resource Consumption

Once SiteWise input is complete, go to "SiteWise_Input Sheet" for overall project and enter information (including Alternative File Name "MEC 2 CTA"). Then go to "Generate Alternative" tab and click button labeled "Click to generate alternative using previously entered alternative name". Copies of the input and output summary sheets for this alternative are now located in the directory titled "RA_MEC 2 CTA_NoFR_1". To store the "Remedial Action Operations.xls" calculation sheet showing detailed calculations, open it in the overall SiteWise project directory when the appropriate input sheet is open, then do a "save as" to put it in the directory for this alternative using a name that indicates "will not update". Then open that file and do "data->edit links" and break the links. If the input sheet for this alternative ever changes, then this calculation sheet needs to be re-saved.

To edit input parameters for this alternative, you must go back to the ORIGINAL SiteWise input sheet and import this alternative using the "Do you want to reload a previously saved remedial alternative in the SiteWise input sheet?" field on the "Site Info" tab. After making necessary changes to the input sheet, re-export the alternative by going to the "Generate Alternative" tab and clicking the button labeled "Click to replace an existing alternative with the same name". Update saved calculation sheets as described above.

Other Supporting Calculations:
MEC Alternative 2 at the Central Test Area MRS

% of Total Energy Usage from Renewable Resources

- None identified

Hazardous Air Pollutants

- None identified

Refined Materials Use

- From SiteWise output sheet for "Remedial Action Construction", the total is 3693 kg = 8125 lbs consisting of:

    - 174.3 kg (steel signs)
    - 363.2 kg (steel posts)
    - 3155.5 kg (concrete)

Unrefined Materials Use

- None identified

Tons of Non-Hazardous Waste

- None identified

Tons of Hazardous Waste

- None identified

% of Potential Waste Recycled

- N/A

Risks to On-Site Workers and from Transportation

- Based on SiteWise output
    - On-Site worker injuries or fatalities = 0
    - Transportation related injuries or fatalities = 0.0017

Heavy Truck Trips through Residential Areas

- None identified

Project: GSR Pilot for IAAAP
Option or Alternative: MEC Alternative 2 at Central Test Area
Current Date: 4/10/2012

year	up-front cost	annual cost	present value of cost each year	cumulative cash flow	
		(no discounting)	2.3%	no discounting	2.3%
0	$51,259	$0	$51,259	$51,259	$51,259
1	$0	$2,975	$2,908	$54,234	$54,167
2	$0	$2,975	$2,843	$57,209	$57,010
3	$0	$2,975	$2,779	$60,184	$59,789
4	$0	$2,975	$2,716	$63,159	$62,505
5	$0	$6,080	$5,427	$69,239	$67,932
6	$0	$2,975	$2,596	$72,214	$70,527
7	$0	$2,975	$2,537	$75,189	$73,064
8	$0	$2,975	$2,480	$78,164	$75,545
9	$0	$2,975	$2,424	$81,139	$77,969
10	$0	$6,080	$4,843	$87,219	$82,812
11	$0	$2,975	$2,317	$90,194	$85,129
12	$0	$2,975	$2,265	$93,169	$87,393
13	$0	$2,975	$2,214	$96,144	$89,607
14	$0	$2,975	$2,164	$99,119	$91,771
15	$0	$6,080	$4,323	$105,199	$96,094
16	$0	$2,975	$2,068	$108,174	$98,161
17	$0	$2,975	$2,021	$111,149	$100,183
18	$0	$2,975	$1,976	$114,124	$102,158
19	$0	$2,975	$1,931	$117,099	$104,090
20	$0	$6,080	$3,858	$123,179	$107,948
21	$0	$2,975	$1,845	$126,154	$109,793
22	$0	$2,975	$1,804	$129,129	$111,597
23	$0	$2,975	$1,763	$132,104	$113,361
24	$0	$2,975	$1,724	$135,079	$115,084
25	$0	$6,080	$3,444	$141,159	$118,528
26	$0	$2,975	$1,647	$144,134	$120,175
27	$0	$2,975	$1,610	$147,109	$121,785
28	$0	$2,975	$1,574	$150,084	$123,359
29	$0	$2,975	$1,538	$153,059	$124,898
30	$0	$6,080	$3,074	$159,139	$127,971

*positive dollar value is a "cost", negative dollar value is a "savings"

Net Present Value (NPV)-> $127,971

Total of capital costs (undiscounted) -> $51,259
Total of annual costs (undiscounted) -> $107,880

GSR Team Calculations to Split Energy Results from SiteWise into "Direct" and "Indirect"
MEC Alternative 2 at the CTA MRS

phase	Reported by SiteWise: activity	Reported by SiteWise: energy used (MMBTU)	Assigned by GSR Team from SiteWise Output: Scope 1 (direct) energy used (MMBTU)	Scope 2 (indirect) energy used (MMBTU)	Scope 3 (indirect) energy used (MMBTU)	Total Calculated by GSR Team
Installation of Engineering Controls ("Remedial Action Construction" tab)	Consumables	20.39	0.00	0.00	20.39	20.39
	Transportation-Personnel	3.74	0.00	0.00	3.74	3.74
	Transportation-Equipment	3.44	0.00	0.00	3.44	3.44
	Equipment Use and Misc	0.00	0.00	0.00	0.00	0.00
	Residual Handling	0.00	0.00	0.00	0.00	0.00
	Sub-Total	27.57	0.00	0.00	27.57	27.57
Annual O&M (“Remedial Action Operations” tab)	Consumables	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	40.49	0.00	0.00	40.49	40.49
	Transportation-Equipment	0.00	0.00	0.00	0.00	0.00
	Equipment Use and Misc	7.17	5.81	0.00	1.36	7.17
	Residual Handling	0.00	0.00	0.00	0.00	0.00
	Sub-Total	47.67	5.81	0.00	41.86	47.67
total		75.23	5.81	0.00	69.42	75.23

Note: Electricity use reported by SiteWise Version 2.0 in units of kWh is “Direct Scope 1”, meaning it is energy consumed at the location of the project. However, energy use associated with electricity reported by SiteWise in units of MMBtu is a life-cycle value which also includes a factor to account for energy used elsewhere required to generate the electricity (“Indirect Scope 2”). Here, 33% of the life-cycle value reported by SiteWise is considered to be "Scope 1" on-site energy use, and 67% is considered to be "Scope 2" energy used in electricity generation.

SiteWise Version 2.0 uses fuel energy values from U.S. Department of Energy, Argonne National Laboratory, Transportation Technology R&D Center, GREET 1.8d.1, Fuel-Cycle model, 2010. This version of the GREET model reports that for Gasoline and Diesel, approximately 19% of GHG emissions are upstream emissions (scope 3) and 81% are tailpipe emissions (scope 1). For this analysis, it is assumed that energy is used in these same proportions, and therefore the energy use reported by SiteWise is split between scope 3 and scope 1 in these ratios.

GSR Team Calculations to Split GHG Results from SiteWise into "Direct" and "Indirect"
MEC Alternative 2 at the CTA MRS

phase	Reported by SiteWise		Assigned by GSR Team from SiteWise Output			Total Calculated by GSR Team
			Scope 1 (direct)	Scope 2 (indirect)	Scope 3 (indirect)	
	activity	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	
Installation of Engineering Controls ("Remedial Action Construction" tab)	Consumables	1.87	0.00	0.00	1.87	1.87
	Transportation-Personnel	0.29	0.00	0.00	0.29	0.29
	Transportation-Equipment	0.25	0.00	0.00	0.25	0.25
	Equipment Use and Misc	0.00	0.00	0.00	0.00	0.00
	Residual Handling	0.00	0.00	0.00	0.00	0.00
	Sub-Total	2.41	0.00	0.00	2.41	2.41
Annual O&M (“Remedial Action Operations” tab)	Consumables	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	3.08	0.00	0.00	3.08	3.08
	Transportation-Equipment	0.00	0.00	0.00	0.00	0.00
	Equipment Use and Misc	0.66	0.53	0.00	0.12	0.66
	Residual Handling	0.00	0.00	0.00	0.00	0.00
	Sub-Total	3.74	0.53	0.00	3.21	3.74
Total		6.15	0.53	0.00	5.62	6.15

Note: CO2e reported by SiteWise Version 2.0 for electricity use is all associated with generation of the electricity (“Indirect Scope 2”).

SiteWise Version 2.0 use fuel emission factors from U.S. Department of Energy, Argonne National Laboratory, Transportation Technology R&D Center, GREET 1.8d.1, Fuel-Cycle model, 2010. This version of the GREET model reports that for gasoline and diesel, approximately 19% of GHG emissions are upstream emissions (Scope 3) and 81% are tailpipe emissions (Scope 1). For this analysis, the GHG emissions reported by SiteWise are split between Scope 3 and Scope 1 in these ratios.

APPENDIX B-2:

MEC Alternative 3 at the Central Test Area MRS

Appendix B-2
Assumptions for SiteWise Input and Other Calculations
Iowa Army Ammunition Plant GSR Evaluation:
MEC Alternative 3 at the Central Test Area MRS

SiteWise "RA_MEC 3 CTA_NoFR_1" Directory

Appendix B-2 of this report includes notes for the footprinting of MEC Alternative 3 at the Central Test Area (CTA) MRS. For the purposes of footprinting, this alternative will involve the following components:

- MEC subsurface clearance over the entire MRS
- Previous RI geophysical data will be used for intrusive investigation
- Intrusive investigation (DGM reacquisition and dig) of 31 acres
- 2 project personnel, two 7-person UXO teams, and two additional UXO specialists conducting field work for 31 days
- Assume approximately 200 anomalies/acre, and an anomaly reacquisition production rate of 200 anomalies per day (GSR Team assumes 10 hour days based on labor hours per acre provided in Draft FS Table A-5-2)
- Assume demilitarization of 40 MD items per acre
- Assume one BIP/consolidated shot per 1000 digs

The specific mass of explosives for BIP has not been quantified, but is assumed to be a "refined material of undetermined but minor quantity".

Unless otherwise noted, SiteWise inputs are based on the information described in Appendix A and the report text of the *Draft Feasibility Study (FS) Report* (dated November 2011). When information required for SiteWise input was not provided, reasonable assumptions were made (these assumptions are noted in the description of SiteWise input below).

The notes pertaining to SiteWise input are organized by the following tabs of the SiteWise input sheet:

- Removal Action Fieldwork – Uses *"Remedial Action Construction"* tab of SiteWise input sheet

For each section of SiteWise, all the sections are listed, with pertinent information added only for those sections of the input sheet where data were added.

In some cases, small quantities of materials were not included in SiteWise input because the footprint of these items relative to the other materials used would be expected to be extremely minimal.

Other calculations done outside of SiteWise are then presented. These include the following:

- % of total energy from renewable resources
- Hazardous air pollutants
- Refined material use
- Unrefined material use

MEC Alternative 3 at CTA – Overview

- Tons of non-hazardous waste
- Tons of hazardous waste
- % of Potential Waste Recycled
- Risks to on-site works and from transportation
- Heavy truck trips through residential areas

Additional tables are attached which show how SiteWise outputs were split into “direct” and “indirect” energy use and greenhouse gas emissions. For definitions of direct and indirect energy use and emissions, please refer to section 2.2.2 of the evaluation report.

Cost calculations are based on cost information provided in Appendix A of the Draft FS. A summary cost sheet developed by the GSR Team is attached to this Appendix. Information regarding the cost calculations is as follows:

- The capital cost is $902,153 and occurs in year 0.

- The annual O&M cost is $0.

- The periodic cost is $3,105, occurring every five years in years 5, 10, 15, 20, 25, and 30.

- The sum of capital, annual, and periodic costs, non-discounted, is $920,783.

- To determine net present value (NPV), a 2.3 percent discount rate is applied to future costs, which is consistent with the discount rate applied in the Draft FS. NPV is calculated by discounting future costs to present-day dollars using the following equation:

$$PV = \frac{FV}{(1+i)^n} = C \times FV$$

PV is the present value
FV is the value in year “n” (i.e., future value)
i is the discount rate
C is the discount factor, which equals $1/(1+i)^n$

- The NPV calculated by the GSR Team is $914,904.

MEC Alternative 3 at CTA – Removal Action Fieldwork

Scope of Work

Appendix A of the Draft FS indicates 31 days of intrusive investigation (DGM reacquisition and dig), assuming approximately 200 anomalies per acre, and an anomaly reacquisition production rate of 200 anomalies per day. Appendix A also appears to (indirectly) indicate 10 hour days, based on labor hours per acre provided in Table A-5-2. The Draft FS assumes one BIP/consolidated shot per 1000 digs and demilitarization of 40 MD items per acre.

It is assumed that intrusive investigations for the various MRSs at IAAAP will be conducted separately (because of their long duration relative to the fencing/signage installation in Alternative 2), and therefore mob/demob footprints are not shared among the MEC Alternative 3 MRSs.

The Draft FS indicates that potential MEC items would be removed to a depth of 2 feet bgs using manual removal techniques (e.g., shovels, hand equipment), no use of heavy machinery is specified. Weights and quantities of materials are not further specified, and are assumed to be minimal (as is shipping of equipment). The GSR Team makes the assumptions indicated below in the SiteWise inputs section.

The following personnel will travel to the site for fieldwork:

- 2 project personnel (1 geophysicist and 1 UXO Tech II) to complete anomaly reacquisition on 6,200 anomalies for 31 days
- Two 7-person UXO dig teams for 31 days
- SUXOS and UXOQCS/SO for removal activities, MEC disposal evolutions, and MPPEH inspections
- Assume that Project Manager to provide project oversight and GIS specialist to maintain GIS anomaly tracking database will not be travelling to the site as a part of field activities (consistent with 18 field personnel noted in the "Per Diem" listing on Table A-5-2). No footprint is calculated for these two personnel.

Based on information provided by the Project Team on the Step 5 call which took place on 11/21/11, the 16 UXO technicians will be travelling alone (i.e., no carpooling) and will travel 8 hours one-way to the site via a combination of air and car. The GSR Team assumes that this will equate to approximately 100 miles via car and 700 miles via plane.

It is further assumed that UXO personnel will be staying in a nearby hotel in Burlington, IA for the extent of field work (31 round trips from the hotel to the site and back for each person). The equipment listed in Table A-5-2 includes 7 pick-up trucks per day for the duration of the remedial action (31 days), presumably for the UXO personnel. It is assumed that these will be used both for personnel transport from the hotel to the site and back and for on-site transport. Assuming that a round trip from the hotel to the site is ~12 miles, and an additional 3 miles per day of on-site transport, the GSR Team assumes a total of 15 miles per truck per day. It is also assumed that workers will carpool 2 or 3 people per vehicle (16 UXO personnel / 7 trucks = average of 2.3 passengers per trip).

The Project Team indicated on the Step 5 call that the regular field technicians will likely be driving from 3 to 4 hours away. The GSR Team assumes that this will equate to approximately 200 miles one way via light truck, and that the two field technicians needed for this project will carpool. The GSR Team assumes that regular field technicians will also stay in a nearby hotel in Burlington, IA for the extent of field work (31 round trips from the hotel to the site and back for each person). In addition, it is assumed that these workers will return home on most weekends (~6 trips from home to the site and back for each person).

MEC Alternative 3 at CTA – Removal Action Fieldwork

<u>Input into “Remedial Action Construction” tab of SiteWise Input Sheet.xls</u>

- Baseline Information
  - Remedial Action Construction Cost
    - Total remedial action construction cost ($) – leave blank in SiteWise

- Material Production
  - Well Materials
  - Treatment Chemicals & Materials
  - Treatment Media
  - Construction Materials
  - Well Decommissioning
  - Bulk Material Quantities

- Transportation
  - Personnel Transportation – Road
    - Trip 1 – UXO Techs, car travel to and from site. Assume a car, gasoline. 100 miles one-way * 2 = 200 miles round trip, 16 trip (since there are 16 UXO personnel travelling separately), 1 traveler per car.
    - Trip 2 – UXO Techs, daily travel from hotel to site and on-site. Assume light trucks, gasoline. 12 miles round trip + 3 miles on-site = 15 miles per day, 31 trips (for each day of field work at site) * 7 trucks = 217 trips, 2.3 travelers per truck (16 UXO techs / 7 trucks).
    - Trip 3 – Regular field technicians, travel to and from site. Assume light trucks, gasoline. 200 miles one-way * 2 = 400 miles round trip, 6 trips (assuming trips home on weekends), 2 travelers per truck trip.
    - Trip 4 – Regular field technicians, daily travel from hotel to site and on-site. Assume light truck, gasoline. 12 miles round trip + 3 miles on-site = 15 miles per day, 31 trips (for each day of field work at site), 2 travelers.
  - Personnel Transportation – Air
    - Trip 1 – UXO Tech, plane travel to and from site. 700 miles one-way * 2 = 1400 miles round trip, 16 traveler, 1 flight each.
  - Personnel Transportation – Rail
  - Equipment Transportation – Road
  - Equipment Transportation – Air
  - Equipment Transportation – Rail
  - Equipment Transportation – Water

- Equipment Use
  - Earthwork
  - Drilling
  - Trenching
  - Pump Operation
  - Diesel and Gasoline Pumps
  - Blower, Compressor, Mixer, and Other Equipment
  - Generators
  - Agricultural Equipment
  - Capping Equipment

  - Mixing Equipment
  - Internal Combustion Engines
  - Other Fueled Equipment
  - Operator Labor
  - Laboratory Analysis
  - Other Known Onsite Activities

- Residual Handling
  - Residue Disposal/Recycling
  - Landfill Operations
  - Thermal/Catalytic Oxidizers

- Resource Consumption
  - Water Consumption
  - Onsite Land and Water Resource Consumption

Once SiteWise input is complete, go to "SiteWise_Input Sheet" for overall project and enter information (including Alternative File Name "MEC 3 CTA"). Then go to "Generate Alternative" tab and click button labeled "Click to generate alternative using previously entered alternative name". Copies of the input and output summary sheets for this alternative are now located in the directory titled "RA_MEC 3 CTA_NoFR_1". To store the "Remedial Action Construction.xls" calculation sheet showing detailed calculations, open it in the overall SiteWise project directory when the appropriate input sheet is open, then do a "save as" to put it in the directory for this alternative using a name that indicates "will not update". Then open that file and do "data->edit links" and break the links. If the input sheet for this alternative ever changes, then this calculation sheet needs to be re-saved.

To edit input parameters for this alternative, you must go back to the ORIGINAL SiteWise input sheet and import this alternative using the "Do you want to reload a previously saved remedial alternative in the SiteWise input sheet?" field on the "Site Info" tab. After making necessary changes to the input sheet, re-export the alternative by going to the "Generate Alternative" tab and clicking the button labeled "Click to replace an existing alternative with the same name". Update saved calculation sheets as described above.

Other Supporting Calculations:
MEC Alternative 3 at the Central Test Area MRS

% of Total Energy Usage from Renewable Resources

- None identified (since remedy construction will not require electricity use)

Hazardous Air Pollutants

- None identified

Refined Materials Use

- None identified. Specific mass of explosives for BIP has not been quantified, but is assumed to be a "refined material of undetermined but minor quantity".

Unrefined Materials Use

- None identified

Tons of Non-Hazardous Waste

- None identified

Tons of Hazardous Waste

- None identified

% of Potential Waste Recycled

- N/A

Risks to On-Site Workers and from Transportation

- Based on SiteWise output
  - On-Site worker injuries or fatalities = 0
  - Transportation related injuries or fatalities = 0.0104

Heavy Truck Trips through Residential Areas

- None identified

Project: GSR Pilot for IAAAP
Option or Alternative: MEC Alternative 3 at Central Test Area
Current Date: 4/10/2012

year	up-front cost	annual cost	present value of cost each year	cumulative cash flow	
		(no discounting)	2.3%	no discounting	2.3%
0	$902,153	$0	$902,153	$902,153	$902,153
1	$0	$0	$0	$902,153	$902,153
2	$0	$0	$0	$902,153	$902,153
3	$0	$0	$0	$902,153	$902,153
4	$0	$0	$0	$902,153	$902,153
5	$0	$3,105	$2,771	$905,258	$904,924
6	$0	$0	$0	$905,258	$904,924
7	$0	$0	$0	$905,258	$904,924
8	$0	$0	$0	$905,258	$904,924
9	$0	$0	$0	$905,258	$904,924
10	$0	$3,105	$2,473	$908,363	$907,398
11	$0	$0	$0	$908,363	$907,398
12	$0	$0	$0	$908,363	$907,398
13	$0	$0	$0	$908,363	$907,398
14	$0	$0	$0	$908,363	$907,398
15	$0	$3,105	$2,208	$911,468	$909,605
16	$0	$0	$0	$911,468	$909,605
17	$0	$0	$0	$911,468	$909,605
18	$0	$0	$0	$911,468	$909,605
19	$0	$0	$0	$911,468	$909,605
20	$0	$3,105	$1,970	$914,573	$911,576
21	$0	$0	$0	$914,573	$911,576
22	$0	$0	$0	$914,573	$911,576
23	$0	$0	$0	$914,573	$911,576
24	$0	$0	$0	$914,573	$911,576
25	$0	$3,105	$1,759	$917,678	$913,334
26	$0	$0	$0	$917,678	$913,334
27	$0	$0	$0	$917,678	$913,334
28	$0	$0	$0	$917,678	$913,334
29	$0	$0	$0	$917,678	$913,334
30	$0	$3,105	$1,570	$920,783	$914,904

*positive dollar value is a "cost", negative dollar value is a "savings"

Net Present Value (NPV)-> $914,904

Total of capital costs (undiscounted) -> $902,153
Total of annual costs (undiscounted) -> $18,630

GSR Team Calculations to Split Energy Results from SiteWise into "Direct" and "Indirect"
MEC Alternative 3 at the CTA MRS

phase	Reported by SiteWise		Assigned by GSR Team from SiteWise Output			Total Calculated by GSR Team
			Scope 1 (direct)	Scope 2 (indirect)	Scope 3 (indirect)	
	activity	energy used (MMBTU)	energy used (MMBTU)	energy used (MMBTU)	energy used (MMBTU)	
Removal Action Fieldwork ("Remedial Action Construction" tab)	Consumables	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	121.56	0.00	0.00	121.56	121.56
	Transportation-Equipment	0.00	0.00	0.00	0.00	0.00
	Equipment Use and Misc	0.00	0.00	0.00	0.00	0.00
	Residual Handling	0.00	0.00	0.00	0.00	0.00
	Sub-Total	121.56	0.00	0.00	121.56	121.56
total		121.56	0.00	0.00	121.56	121.56

Note: Electricity use reported by SiteWise Version 2.0 in units of kWh is "Direct Scope 1", meaning it is energy consumed at the location of the project. However, energy use associated with electricity reported by SiteWise in units of MMBtu is a life-cycle value which also includes a factor to account for energy used elsewhere required to generate the electricity ("Indirect Scope 2"). Here, 33% of the life-cycle value reported by SiteWise is considered to be "Scope 1" on-site energy use, and 67% is considered to be "Scope 2" energy used in electricity generation.

SiteWise Version 2.0 uses fuel energy values from U.S. Department of Energy, Argonne National Laboratory, Transportation Technology R&D Center, GREET 1.8d.1, Fuel-Cycle model, 2010. This version of the GREET model reports that for Gasoline and Diesel, approximately 19% of GHG emissions are upstream emissions (scope 3) and 81% are tailpipe emissions (scope 1). For this analysis, it is assumed that energy is used in these same proportions, and therefore the energy use reported by SiteWise is split between scope 3 and scope 1 in these ratios.

GSR Team Calculations to Split GHG Results from SiteWise into "Direct" and "Indirect"
MEC Alternative 3 at the CTA MRS

phase	Reported by SiteWise		Assigned by GSR Team from SiteWise Output			Total Calculated by GSR Team
			Scope 1 (direct)	Scope 2 (indirect)	Scope 3 (indirect)	
	activity	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	
Removal Action Fieldwork ("Remedial Action Construction" tab)	Consumables	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	9.36	0.00	0.00	9.36	9.36
	Transportation-Equipment	0.00	0.00	0.00	0.00	0.00
	Equipment Use and Misc	0.00	0.00	0.00	0.00	0.00
	Residual Handling	0.00	0.00	0.00	0.00	0.00
	Sub-Total	9.36	0.00	0.00	9.36	9.36
Total		9.36	0.00	0.00	9.36	9.36

Note: CO2e reported by SiteWise Version 2.0 for electricity use is all associated with generation of the electricity ("Indirect Scope 2").

SiteWise Version 2.0 use fuel emission factors from U.S. Department of Energy, Argonne National Laboratory, Transportation Technology R&D Center, GREET 1.8d.1, Fuel-Cycle model, 2010. This version of the GREET model reports that for gasoline and diesel, approximately 19% of GHG emissions are upstream emissions (Scope 3) and 81% are tailpipe emissions (Scope 1). For this analysis, the GHG emissions reported by SiteWise are split between Scope 3 and Scope 1 in these ratios.

APPENDIX B-3:

MEC Alternative 2 at the Line 6 Ammo Production (Inside Blast Radii) MRS

Appendix B-3
Assumptions for SiteWise Input and Other Calculations
Iowa Army Ammunition Plant GSR Evaluation:
MEC Alternative 2 at the Line 6 Ammo Production (Inside Blast Radii) MRS

SiteWise "RA_MEC 2 LL6_NoFR_1" Directory

Appendix B-3 of this report includes notes for the footprinting of MEC Alternative 2 at the Line 6 Ammo Production (Inside Blast Radii) (LL6) MRS. For the purposes of footprinting, this alternative will involve the following components:

- Security fencing already in place around perimeter of the MRS (no additional fencing needed)
- Installation of signage every 100 ft along MRS boundary
- UXO escort during sign installation
- Annual O&M, including mowing along fence line and sign and fence inspection and maintenance

Unless otherwise noted, SiteWise inputs are based on the information described in Appendix A and the report text of the *Draft Feasibility Study (FS) Report* (dated November 2011). When information required for SiteWise input was not provided, reasonable assumptions were made (these assumptions are noted in the description of SiteWise input below).

The notes pertaining to SiteWise input are organized by the following tabs of the SiteWise input sheet:

- Installation of Engineering Controls – Uses *"Remedial Action Construction"* tab of SiteWise input sheet
- Annual O&M – Uses *"Remedial Action Operations"* tab of SiteWise input sheet

For each section of SiteWise, all the sections are listed, with pertinent information added only for those sections of the input sheet where data were added.

In some cases, small quantities of materials were not included in SiteWise input because the footprint of these items relative to the other materials used would be expected to be extremely minimal.

Other calculations done outside of SiteWise are then presented. These include the following:

- % of total energy from renewable resources
- Hazardous air pollutants
- Refined material use
- Unrefined material use
- Tons of non-hazardous waste
- Tons of hazardous waste
- % of Potential Waste Recycled
- Risks to on-site works and from transportation
- Heavy truck trips through residential areas

MEC Alternative 2 at LL6 – Overview

Additional tables are attached which show how SiteWise outputs were split into "direct" and "indirect" energy use and greenhouse gas emissions. For definitions of direct and indirect energy use and emissions, please refer to section 2.2.2 of the evaluation report.

Cost calculations are based on cost information provided in Appendix A of the Draft FS. A summary cost sheet developed by the GSR Team is attached to this Appendix. Information regarding the cost calculations is as follows:

- The capital cost is $45,098 and occurs in year 0.
- The annual O&M cost is $2,890, occurring each year in years 1 through 30.
- The periodic cost is $3,105, occurring every five years in years 5, 10, 15, 20, 25, and 30.
- The sum of capital, annual, and periodic costs, non-discounted, is $150,428.
- To determine net present value (NPV), a 2.3 percent discount rate is applied to future costs, which is consistent with the discount rate applied in the Draft FS. NPV is calculated by discounting future costs to present-day dollars using the following equation:

$$PV = \frac{FV}{(1+i)^n} = C \times FV$$

  PV is the present value
  FV is the value in year "n" (i.e., future value)
  i is the discount rate
  C is the discount factor, which equals $1/(1+i)^n$

- The NPV calculated by the GSR Team is $119,983.

MEC Alternative 2 at LL6 – Installation of Engineering Controls

Scope of Work

Appendix A of the Draft FS indicates that signs will be installed every 100 ft for 2,193 ft along the CTA MRS boundary at a production rate of 1,500 ft per hr. 2,193 ft / 1,500 ft per hour = 1.46 hours total.

It is assumed that signage installation for MEC Alternative 2 at CTA and LL6 will be completed with one mobilization (the Draft FS text indicates that fencing and signage will be in place at PDS and INDA by the time the FS is finalized, and are therefore not included). To account for this, SiteWise inputs related to mob/demob for installation of engineering controls for MEC Alternative 2 at these two MRSs are divided by 2.

Appendix A of the Draft FS indicates that the necessary materials include signs (22 total for LL6), steel posts (galvanized, 10' upright, GSR Team assumes one per sign), and normal weight concrete (ready mix). Weights and quantities of these materials are not further specified; the GSR Team makes the assumptions indicated below in the SiteWise inputs section.

Appendix A of the Draft FS indicates that one UXO Tech II will be needed for anomaly avoidance during sign installation. Based on information provided by the Project Team on the Step 5 call which took place on 11/21/11, UXO technicians will be travelling alone (i.e., no carpooling) and will travel 8 hours one-way to the site via a combination of air and car. The GSR Team assumes that this will equate to approximately 100 miles via car and 700 miles via plane. It is further assumed that the UXO Tech will be staying in a nearby hotel in Burlington, IA (~12 miles round trip to site and back) for two nights.

The Project Team indicated on the Step 5 call that a local vendor out of Davenport (~89 miles one-way) will be used for the fencing, and the GSR Team assumes that this same vendor will be used for signage. The GSR Team assumes that two workers from this local contractor will be needed to drive the steel posts and install signs. Since installation of signage for both the CTA and LL6 should take less than one day total and the contractor is within reasonable driving distance of the site, it is assumed that the workers will not be staying overnight in a hotel.

MEC Alternative 2 at LL6 – Installation of Engineering Controls

<u>Input into "Remedial Action Construction" tab of SiteWise Input Sheet.xls</u>

- Baseline Information
    - Remedial Action Construction Cost
        - Total remedial action construction cost ($) – leave blank in SiteWise

- Material Production
    - Well Materials
    - Treatment Chemicals & Materials
    - Treatment Media
    - Construction Materials
    - Well Decommissioning
    - Bulk Material Quantities
        - Material 1 – Signs. Select steel to represent galvanized steel (assumed) and units of cubic feet. Assume each sign is roughly 0.05" thick * 24" tall * 24" wide = 28.8 cubic inches / 1728 cubic inches per cubic foot = 0.016667 cubic feet per sign * 22 signs = 0.366667 cubic feet total.
        - Material 2 – Steel posts. Select steel to represent galvanized steel and units of cubic feet. Each post will be 10 feet tall, and assume roughly 0.25" thick * 2" wide. 120" * 0.25" * 2" = 60 cubic inches / 1728 cubic inches per cubic foot = 0.034722 cubic feet per post * 22 posts = 0.763889 cubic feet total.
        - Material 3 – Normal weight concrete. Select general concrete and units of cubic feet. Assume a 1 cubic foot block of concrete per sign. 1 cubic foot per sign * 22 signs = 22 cubic feet total.

- Transportation
    - Personnel Transportation – Road
        - Trip 1 – UXO Tech, car travel to and from site. Assume a car, gasoline. 100 miles one-way * 2 = 200 miles round trip / 2 (accounting for shared mobilization with CTA MRS) = 100 miles, 1 trip, 1 traveler.
        - Trip 2 – UXO Tech, daily car travel from hotel to site. Assume a car, gasoline. 12 miles round trip / 2 (accounting for shared mobilization with CTA MRS) = 6 miles, 1 trip (for one day of field work at site), 1 traveler.
        - Trip 3 – Contractor for signage. Assume light trucks, gasoline. 89 miles one-way * 2 = 178 miles round trip / 2 (accounting for shared mobilization with LL6 MRS) = 89 miles, 2 trip (assuming two separate trucks needed to transport materials), 1 traveler per truck.
    - Personnel Transportation – Air
        - Trip 1 – UXO Tech, plane travel to and from site. 700 miles one-way * 2 = 1400 miles round trip / 2 (accounting for shared mobilization with CTA MRS) = 700 miles, 1 traveler, 1 flight.
    - Personnel Transportation – Rail
    - Equipment Transportation – Road
        - Trip 1 – Transport of all sign materials to site. Assuming these materials will be brought to site with contractor, select gasoline and 89 miles one way * 2 trucks = 178 miles. (Do not need to account for shared mobilization with CTA MRS here, since transport of sign materials for CTA will be included separately in the SiteWise input for that MRS. The equipment transport footprints for CTA and

LL6 will be slightly different due to the difference in weight of the materials.) Estimated total weight (from SiteWise output sheet) = 81.6 kg (steel signs) + 170.0 kg (steel posts) + 1477.1 kg (concrete) = 1728.7 kg / 907.18 kg per ton = 1.9 tons / 2 trucks = 0.95 tons per truck. Since fuel use for contractor return trips is already accounted for in Personnel Transportation Trip 3 above, no empty return trips are included here.

  - Equipment Transportation – Air
  - Equipment Transportation – Rail
  - Equipment Transportation – Water

- Equipment Use
  - Earthwork
  - Drilling
  - Trenching
  - Pump Operation
  - Diesel and Gasoline Pumps
  - Blower, Compressor, Mixer, and Other Equipment
  - Generators
  - Agricultural Equipment
  - Capping Equipment
  - Mixing Equipment
  - Internal Combustion Engines
  - Other Fueled Equipment
  - Operator Labor
  - Laboratory Analysis
  - Other Known Onsite Activities

- Residual Handling
  - Residue Disposal/Recycling
  - Landfill Operations
  - Thermal/Catalytic Oxidizers

- Resource Consumption
  - Water Consumption
  - Onsite Land and Water Resource Consumption

Once SiteWise input is complete, go to "SiteWise_Input Sheet" for overall project and enter information (including Alternative File Name "MEC 2 LL6"). Then go to "Generate Alternative" tab and click button labeled "Click to generate alternative using previously entered alternative name". Copies of the input and output summary sheets for this alternative are now located in the directory titled "RA_MEC 2 LL6_NoFR_1". To store the "Remedial Action Construction.xls" calculation sheet showing detailed calculations, open it in the overall SiteWise project directory when the appropriate input sheet is open, then do a "save as" to put it in the directory for this alternative using a name that indicates "will not update". Then open that file and do "data->edit links" and break the links. If the input sheet for this alternative ever changes, then this calculation sheet needs to be re-saved.

MEC Alternative 2 at LL6 – Installation of Engineering Controls

To edit input parameters for this alternative, you must go back to the ORIGINAL SiteWise input sheet and import this alternative using the "Do you want to reload a previously saved remedial alternative in the SiteWise input sheet?" field on the "Site Info" tab. After making necessary changes to the input sheet, re-export the alternative by going to the "Generate Alternative" tab and clicking the button labeled "Click to replace an existing alternative with the same name". Update saved calculation sheets as described above.

MEC Alternative 2 at LL6 – Annual O&M

Scope of Work

Appendix A of the Draft FS indicates that one UXO Tech II will be needed for annual sign and fence inspection and maintenance. Based on information provided by the Project Team on the Step 5 call which took place on 11/21/11, UXO technicians will be travelling alone (i.e., no carpooling) and will travel 8 hours one-way to the site via a combination of air and car. The GSR Team assumes that this will equate to approximately 100 miles via car and 700 miles via plane per year for 30 years of O&M.

The cost information in Appendix A of the Draft FS indicates that a UXO Tech II will be needed for the following number of hours at each MRS (per year):

- CTA – 20 hrs
- LL6 – 20 hrs
- PDS – 10 hrs
- INDA – 40 hrs

Assuming that one UXO Tech will be utilized to inspect the signs and fences at all MRSs during a single trip to the site each year, the SiteWise inputs associated with travel to the local are for each MEC Alternative 2 at these four MRSs are divided by 4. Trips from the hotel to the site and back are assigned based on the number of hours spent at each MRS listed above, assuming 10 hour days. For LL6, this means two 12-mile round trips from the hotel to the site (one per day).

Appendix A of the Draft FS indicates that mowing will be required in the 10 ft^2 along 2,193 LF of the MRS fence line. The GSR Team assumes ~0.5 hours per acre * 0.5 acres to be mowed * mowing 2 times per year = 0.5 hours per year to mow area around CTA fence with large riding mower, such as those found at: http://www.deere.com/wps/dcom/en_US/products/equipment/front_mowers/front_mowers.page. The website indicates that the majority of these mowers run on diesel, and that each has a 16 gallon fuel tank that allows for 10 hours of runtime without refueling. Based on this statement, it is estimated that a mower of this size would have a consumption rate of 1.6 gallons per hour (16 gallons / 10 hours).

It is assumed that mowing at all 4 MRSs will be completed as a part of regular installation maintenance, and therefore a separate mob/demob for personnel is not included in the footprint for each MRS. It is also assumed that the mower is already owned and maintained by the installation, and mob/demob for the mower is not part of the footprint for each MRS. The footprint associated with mowing is therefore comprised only of the fuel usage required for mowing the specified area.

MEC Alternative 2 at LL6 – Annual O&M

Input into "Remedial Action Operations" tab of SiteWise Input Sheet.xls

- Baseline Information
  - Remedial Action Operations Cost and Duration
    - Total remedial action operations cost ($) – leave blank in SiteWise
    - Duration of remedial action operations (unit time) – 1 yr for this GSR evaluation because we have multiplied input items by number of years as part of the input

- Material Production
  - Well Materials
  - Treatment Chemicals & Materials
  - Treatment Media
  - Construction Materials
  - Well Decommissioning
  - Bulk Material Quantities

- Transportation
  - Personnel Transportation – Road
    - Trip 1 – UXO Tech, car travel to and from site. Assume a car, gasoline. 100 miles one-way * 2 = 200 miles round trip / 4 (accounting for shared mobilization with other MRSs) = 50 miles, 1 trip per year for 30 years = 30 trips, 1 traveler.
    - Trip 2 – UXO Tech, daily car travel from hotel to site. Assume a car, gasoline. 12 miles round trip, 2 trips (for 2 days of field work at site, assuming 10 hour days) per year for 30 years = 60 trips, 1 traveler.
  - Personnel Transportation – Air
    - Trip 1 – UXO Tech, plane travel to and from site. 700 miles one-way * 2 = 1400 miles round trip / 4 (accounting for shared mobilization with other MRSs) = 350 miles, 1 traveler, 1 flight per year for 30 years = 30 flights.
  - Personnel Transportation – Rail
  - Equipment Transportation – Road
  - Equipment Transportation – Air
  - Equipment Transportation – Rail
  - Equipment Transportation – Water

- Equipment Use
  - Earthwork
  - Drilling
  - Trenching
  - Pump Operation
  - Diesel and Gasoline Pumps
  - Blower, Compressor, Mixer, and Other Equipment
  - Generators
  - Agricultural Equipment
  - Capping Equipment
  - Mixing Equipment
  - Internal Combustion Engines

        - Engine 1 – Large riding mower for mowing along MRS fence line. Assume diesel, fuel consumption rate of 1.6 gal/hr, 0.5 hours of operation per year * 30 years = 15 hours.
    - Other Fueled Equipment
    - Operator Labor
    - Laboratory Analysis
    - Other Known Onsite Activities

- Residual Handling
    - Residue Disposal/Recycling
    - Landfill Operations
    - Thermal/Catalytic Oxidizers

- Resource Consumption
    - Water Consumption
    - Onsite Land and Water Resource Consumption

Once SiteWise input is complete, go to "SiteWise_Input Sheet" for overall project and enter information (including Alternative File Name "MEC 2 LL6"). Then go to "Generate Alternative" tab and click button labeled "Click to generate alternative using previously entered alternative name". Copies of the input and output summary sheets for this alternative are now located in the directory titled "RA_MEC 2 LL6_NoFR_1". To store the "Remedial Action Operations.xls" calculation sheet showing detailed calculations, open it in the overall SiteWise project directory when the appropriate input sheet is open, then do a "save as" to put it in the directory for this alternative using a name that indicates "will not update". Then open that file and do "data->edit links" and break the links. If the input sheet for this alternative ever changes, then this calculation sheet needs to be re-saved.

To edit input parameters for this alternative, you must go back to the ORIGINAL SiteWise input sheet and import this alternative using the "Do you want to reload a previously saved remedial alternative in the SiteWise input sheet?" field on the "Site Info" tab. After making necessary changes to the input sheet, re-export the alternative by going to the "Generate Alternative" tab and clicking the button labeled "Click to replace an existing alternative with the same name". Update saved calculation sheets as described above.

Other Supporting Calculations:
MEC Alternative 2 at the Line 6 Ammo Production (Inside Blast Radii) MRS

% of Total Energy Usage from Renewable Resources

- None identified

Hazardous Air Pollutants

- None identified

Refined Materials Use

- From SiteWise output sheet for "Remedial Action Construction", the total is 1729 kg = 3804 lbs consisting of:
    - 81.6 kg (steel signs)
    - 170.0 kg (steel posts)
    - 1477.1 kg (concrete)

Unrefined Materials Use

- None identified

Tons of Non-Hazardous Waste

- None identified

Tons of Hazardous Waste

- None identified

% of Potential Waste Recycled

- N/A

Risks to On-Site Workers and from Transportation

- Based on SiteWise output
    - On-Site worker injuries or fatalities = 0
    - Transportation related injuries or fatalities = 0.0017

Heavy Truck Trips through Residential Areas

- None identified

Project: GSR Pilot for IAAAP
Option or Alternative: MEC Alternative 2 at Line 6 Ammo Production (Inside Blast Radii)
Current Date: 4/10/2012

year	up-front cost	annual cost	present value of cost each year	cumulative cash flow	
		(no discounting)	2.3%	no discounting	2.3%
0	$45,098	$0	$45,098	$45,098	$45,098
1	$0	$2,890	$2,825	$47,988	$47,923
2	$0	$2,890	$2,762	$50,878	$50,685
3	$0	$2,890	$2,699	$53,768	$53,384
4	$0	$2,890	$2,639	$56,658	$56,023
5	$0	$5,995	$5,351	$62,653	$61,373
6	$0	$2,890	$2,521	$65,543	$63,895
7	$0	$2,890	$2,465	$68,433	$66,360
8	$0	$2,890	$2,409	$71,323	$68,769
9	$0	$2,890	$2,355	$74,213	$71,124
10	$0	$5,995	$4,776	$80,208	$75,900
11	$0	$2,890	$2,250	$83,098	$78,150
12	$0	$2,890	$2,200	$85,988	$80,350
13	$0	$2,890	$2,150	$88,878	$82,500
14	$0	$2,890	$2,102	$91,768	$84,602
15	$0	$5,995	$4,262	$97,763	$88,865
16	$0	$2,890	$2,009	$100,653	$90,873
17	$0	$2,890	$1,963	$103,543	$92,837
18	$0	$2,890	$1,919	$106,433	$94,756
19	$0	$2,890	$1,876	$109,323	$96,632
20	$0	$5,995	$3,804	$115,318	$100,436
21	$0	$2,890	$1,793	$118,208	$102,229
22	$0	$2,890	$1,752	$121,098	$103,982
23	$0	$2,890	$1,713	$123,988	$105,695
24	$0	$2,890	$1,674	$126,878	$107,369
25	$0	$5,995	$3,395	$132,873	$110,764
26	$0	$2,890	$1,600	$135,763	$112,365
27	$0	$2,890	$1,564	$138,653	$113,929
28	$0	$2,890	$1,529	$141,543	$115,457
29	$0	$2,890	$1,495	$144,433	$116,952
30	$0	$5,995	$3,031	$150,428	$119,983

*positive dollar value is a "cost", negative dollar value is a "savings"

Net Present Value (NPV)-> $119,983

Total of capital costs (undiscounted) -> $45,098
Total of annual costs (undiscounted) -> $105,330

GSR Team Calculations to Split Energy Results from SiteWise into "Direct" and "Indirect"
MEC Alternative 2 at the LL6 MRS

phase	Reported by SiteWise activity	energy used (MMBTU)	Assigned by GSR Team from SiteWise Output: Scope 1 (direct) energy used (MMBTU)	Scope 2 (indirect) energy used (MMBTU)	Scope 3 (indirect) energy used (MMBTU)	Total Calculated by GSR Team
Installation of Engineering Controls ("Remedial Action Construction" tab)	Consumables	9.54	0.00	0.00	9.54	9.54
	Transportation-Personnel	3.74	0.00	0.00	3.74	3.74
	Transportation-Equipment	3.39	0.00	0.00	3.39	3.39
	Equipment Use and Misc	0.00	0.00	0.00	0.00	0.00
	Residual Handling	0.00	0.00	0.00	0.00	0.00
	Sub-Total	16.67	0.00	0.00	16.67	16.67
Annual O&M (“Remedial Action Operations” tab)	Consumables	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	40.49	0.00	0.00	40.49	40.49
	Transportation-Equipment	0.00	0.00	0.00	0.00	0.00
	Equipment Use and Misc	3.26	2.64	0.00	0.62	3.26
	Residual Handling	0.00	0.00	0.00	0.00	0.00
	Sub-Total	43.75	2.64	0.00	41.11	43.75
total		60.42	2.64	0.00	57.78	60.42

Note: Electricity use reported by SiteWise Version 2.0 in units of kWh is “Direct Scope 1”, meaning it is energy consumed at the location of the project. However, energy use associated with electricity reported by SiteWise in units of MMBtu is a life-cycle value which also includes a factor to account for energy used elsewhere required to generate the electricity (“Indirect Scope 2”). Here, 33% of the life-cycle value reported by SiteWise is considered to be "Scope 1" on-site energy use, and 67% is considered to be "Scope 2" energy used in electricity generation.

SiteWise Version 2.0 uses fuel energy values from U.S. Department of Energy, Argonne National Laboratory, Transportation Technology R&D Center, GREET 1.8d.1, Fuel-Cycle model, 2010. This version of the GREET model reports that for Gasoline and Diesel, approximately 19% of GHG emissions are upstream emissions (scope 3) and 81% are tailpipe emissions (scope 1). For this analysis, it is assumed that energy is used in these same proportions, and therefore the energy use reported by SiteWise is split between scope 3 and scope 1 in these ratios.

GSR Team Calculations to Split GHG Results from SiteWise into "Direct" and "Indirect"
MEC Alternative 2 at the LL6 MRS

phase	Reported by SiteWise		Assigned by GSR Team from SiteWise Output			Total Calculated by GSR Team
			Scope 1 (direct)	Scope 2 (indirect)	Scope 3 (indirect)	
	activity	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	
Installation of Engineering Controls ("Remedial Action Construction" tab)	Consumables	0.88	0.00	0.00	0.88	0.88
	Transportation-Personnel	0.29	0.00	0.00	0.29	0.29
	Transportation-Equipment	0.25	0.00	0.00	0.25	0.25
	Equipment Use and Misc	0.00	0.00	0.00	0.00	0.00
	Residual Handling	0.00	0.00	0.00	0.00	0.00
	Sub-Total	1.41	0.00	0.00	1.41	1.41
Annual O&M (“Remedial Action Operations” tab)	Consumables	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	3.08	0.00	0.00	3.08	3.08
	Transportation-Equipment	0.00	0.00	0.00	0.00	0.00
	Equipment Use and Misc	0.30	0.24	0.00	0.06	0.30
	Residual Handling	0.00	0.00	0.00	0.00	0.00
	Sub-Total	3.38	0.24	0.00	3.14	3.38
Total		4.79	0.24	0.00	4.55	4.79

Note: CO2e reported by SiteWise Version 2.0 for electricity use is all associated with generation of the electricity (“Indirect Scope 2”).

SiteWise Version 2.0 use fuel emission factors from U.S. Department of Energy, Argonne National Laboratory, Transportation Technology R&D Center, GREET 1.8d.1, Fuel-Cycle model, 2010. This version of the GREET model reports that for gasoline and diesel, approximately 19% of GHG emissions are upstream emissions (Scope 3) and 81% are tailpipe emissions (Scope 1). For this analysis, the GHG emissions reported by SiteWise are split between Scope 3 and Scope 1 in these ratios.

APPENDIX B-4:

MEC Alternative 3 at the Line 6 Ammo Production (Inside Blast Radii) MRS

Appendix B-4
Assumptions for SiteWise Input and Other Calculations
Iowa Army Ammunition Plant GSR Evaluation:
MEC Alternative 3 at the Line 6 Ammo Production (Inside Blast Radii) MRS

SiteWise "RA_MEC 3 LL6_NoFR_1" Directory

Appendix B-4 of this report includes notes for the footprinting of MEC Alternative 3 at the Line 6 Ammo Production (Inside Blast Radii) (LL6) MRS. For the purposes of footprinting, this alternative will involve the following components:

- MEC subsurface clearance over the entire MRS
- Previous RI geophysical data will be used for intrusive investigation
- Intrusive investigation (DGM reacquisition and dig) of 8 acres
- 2 project personnel, two 7-person UXO teams, and two additional UXO specialists conducting field work for 8 days
- Assume approximately 200 anomalies/acre, and an anomaly reacquisition production rate of 200 anomalies per day (GSR Team assumes 10 hour days based on labor hours per acre provided in Draft FS Table A-5-2)
- Assume demilitarization of 40 MD items per acre
- Assume one BIP/consolidated shot per 1000 digs

The specific mass of explosives for BIP has not been quantified, but is assumed to be a "refined material of undetermined but minor quantity".

Unless otherwise noted, SiteWise inputs are based on the information described in Appendix A and the report text of the *Draft Feasibility Study (FS) Report* (dated November 2011). When information required for SiteWise input was not provided, reasonable assumptions were made (these assumptions are noted in the description of SiteWise input below).

The notes pertaining to SiteWise input are organized by the following tabs of the SiteWise input sheet:

- Removal Action Fieldwork – Uses *"Remedial Action Construction"* tab of SiteWise input sheet

For each section of SiteWise, all the sections are listed, with pertinent information added only for those sections of the input sheet where data were added.

In some cases, small quantities of materials were not included in SiteWise input because the footprint of these items relative to the other materials used would be expected to be extremely minimal.

Other calculations done outside of SiteWise are then presented. These include the following:

- % of total energy from renewable resources
- Hazardous air pollutants
- Refined material use
- Unrefined material use

- Tons of non-hazardous waste
- Tons of hazardous waste
- % of Potential Waste Recycled
- Risks to on-site works and from transportation
- Heavy truck trips through residential areas

Additional tables are attached which show how SiteWise outputs were split into "direct" and "indirect" energy use and greenhouse gas emissions. For definitions of direct and indirect energy use and emissions, please refer to section 2.2.2 of the evaluation report.

Cost calculations are based on cost information provided in Appendix A of the Draft FS. A summary cost sheet developed by the GSR Team is attached to this Appendix. Information regarding the cost calculations is as follows:

- The capital cost is $332,510 and occurs in year 0.

- The annual O&M cost is $0.

- The periodic cost is $3,105, occurring every five years in years 5, 10, 15, 20, 25, and 30.

- The sum of capital, annual, and periodic costs, non-discounted, is $351,140.

- To determine net present value (NPV), a 2.3 percent discount rate is applied to future costs, which is consistent with the discount rate applied in the Draft FS. NPV is calculated by discounting future costs to present-day dollars using the following equation:

$$PV = \frac{FV}{(1+i)^n} = C \times FV$$

  PV is the present value
  FV is the value in year "n" (i.e., future value)
  i is the discount rate
  C is the discount factor, which equals $1/(1+i)^n$

- The NPV calculated by the GSR Team is $345,261.

MEC Alternative 3 at LL6 – Removal Action Fieldwork

<u>*Scope of Work*</u>

Appendix A of the Draft FS indicates 8 days of intrusive investigation (DGM reacquisition and dig), assuming approximately 200 anomalies per acre, and an anomaly reacquisition production rate of 200 anomalies per day. Appendix A also appears to (indirectly) indicate 10 hour days, based on labor hours per acre provided in Table A-5-2. The Draft FS assumes one BIP/consolidated shot per 1000 digs and demilitarization of 40 MD items per acre.

It is assumed that intrusive investigations for the various MRSs at IAAAP will be conducted separately (because of their long duration relative to the fencing/signage installation in Alternative 2), and therefore mob/demob footprints are not shared among the MEC Alternative 3 MRSs.

The Draft FS indicates that potential MEC items would be removed to a depth of 2 feet bgs using manual removal techniques (e.g., shovels, hand equipment), no use of heavy machinery is specified. Weights and quantities of materials are not further specified, and are assumed to be minimal (as is shipping of equipment). The GSR Team makes the assumptions indicated below in the SiteWise inputs section.

The following personnel will travel to the site for fieldwork:

- 2 project personnel (1 geophysicist and 1 UXO Tech II) to complete anomaly reacquisition on 1,600 anomalies for 8 days
- Two 7-person UXO dig teams for 8 days
- SUXOS and UXOQCS/SO for removal activities, MEC disposal evolutions, and MPPEH inspections
- Assume that Project Manager to provide project oversight and GIS specialist to maintain GIS anomaly tracking database will not be travelling to the site as a part of field activities (consistent with 18 field personnel noted in the "Per Diem" listing on Table A-5-2). No footprint is calculated for these two personnel.

Based on information provided by the Project Team on the Step 5 call which took place on 11/21/11, the 16 UXO technicians will be travelling alone (i.e., no carpooling) and will travel 8 hours one-way to the site via a combination of air and car. The GSR Team assumes that this will equate to approximately 100 miles via car and 700 miles via plane.

It is further assumed that UXO personnel will be staying in a nearby hotel in Burlington, IA for the extent of field work (8 round trips from the hotel to the site and back for each person). The equipment listed in Table A-5-2 includes 7 pick-up trucks per day for the duration of the remedial action (8 days), presumably for the UXO personnel. It is assumed that these will be used both for personnel transport from the hotel to the site and back and for on-site transport. Assuming that a round trip from the hotel to the site is ~12 miles, and an additional 3 miles per day of on-site transport, the GSR Team assumes a total of 15 miles per truck per day. It is also assumed that workers will carpool 2 or 3 people per vehicle (16 UXO personnel / 7 trucks = average of 2.3 passengers per trip).

The Project Team indicated on the Step 5 call that the regular field technicians will likely be driving from 3 to 4 hours away. The GSR Team assumes that this will equate to approximately 200 miles one way via light truck, and that the two field technicians needed for this project will carpool. The GSR Team assumes that regular field technicians will also stay in a nearby hotel in Burlington, IA for the extent of field work (8 round trips from the hotel to the site and back for each person). Due to the relatively short duration of the field work (compared to MEC Alternative 3 at the other MRSs), it is assumed that both field technicians will only make one round trip from home to the site area.

MEC Alternative 3 at LL6 – Removal Action Fieldwork

<u>Input into “Remedial Action Construction” tab of SiteWise Input Sheet.xls</u>

- Baseline Information
  - Remedial Action Construction Cost
    - Total remedial action construction cost ($) – leave blank in SiteWise

- Material Production
  - Well Materials
  - Treatment Chemicals & Materials
  - Treatment Media
  - Construction Materials
  - Well Decommissioning
  - Bulk Material Quantities

- Transportation
  - Personnel Transportation – Road
    - Trip 1 – UXO Techs, car travel to and from site. Assume a car, gasoline. 100 miles one-way * 2 = 200 miles round trip, 16 trip (since there are 16 UXO personnel travelling separately), 1 traveler per car.
    - Trip 2 – UXO Techs, daily travel from hotel to site and on-site. Assume light trucks, gasoline. 12 miles round trip + 3 miles on-site = 15 miles per day, 8 trips (for each day of field work at site) * 7 trucks = 56 trips, 2.3 travelers per truck (16 UXO techs / 7 trucks).
    - Trip 3 – Regular field technicians, travel to and from site. Assume light trucks, gasoline. 200 miles one-way * 2 = 400 miles round trip, 1 trip (assuming no additional trips home over weekend), 2 travelers per truck trip.
    - Trip 4 – Regular field technicians, daily travel from hotel to site and on-site. Assume light truck, gasoline. 12 miles round trip + 3 miles on-site = 15 miles per day, 8 trips (for each day of field work at site), 2 travelers.
  - Personnel Transportation – Air
    - Trip 1 – UXO Tech, plane travel to and from site. 700 miles one-way * 2 = 1400 miles round trip, 16 traveler, 1 flight each.
  - Personnel Transportation – Rail
  - Equipment Transportation – Road
  - Equipment Transportation – Air
  - Equipment Transportation – Rail
  - Equipment Transportation – Water

- Equipment Use
  - Earthwork
  - Drilling
  - Trenching
  - Pump Operation
  - Diesel and Gasoline Pumps
  - Blower, Compressor, Mixer, and Other Equipment
  - Generators
  - Agricultural Equipment
  - Capping Equipment

- Mixing Equipment
- Internal Combustion Engines
- Other Fueled Equipment
- Operator Labor
- Laboratory Analysis
- Other Known Onsite Activities

- Residual Handling
  - Residue Disposal/Recycling
  - Landfill Operations
  - Thermal/Catalytic Oxidizers

- Resource Consumption
  - Water Consumption
  - Onsite Land and Water Resource Consumption

Once SiteWise input is complete, go to “SiteWise_Input Sheet” for overall project and enter information (including Alternative File Name “MEC 3 LL6”). Then go to “Generate Alternative” tab and click button labeled “Click to generate alternative using previously entered alternative name”. Copies of the input and output summary sheets for this alternative are now located in the directory titled “RA_MEC 3 LL6_NoFR_1”. To store the “Remedial Action Construction.xls” calculation sheet showing detailed calculations, open it in the overall SiteWise project directory when the appropriate input sheet is open, then do a “save as” to put it in the directory for this alternative using a name that indicates “will not update”. Then open that file and do “data->edit links” and break the links. If the input sheet for this alternative ever changes, then this calculation sheet needs to be re-saved.

To edit input parameters for this alternative, you must go back to the ORIGINAL SiteWise input sheet and import this alternative using the “Do you want to reload a previously saved remedial alternative in the SiteWise input sheet?” field on the “Site Info” tab. After making necessary changes to the input sheet, re-export the alternative by going to the “Generate Alternative” tab and clicking the button labeled “Click to replace an existing alternative with the same name”. Update saved calculation sheets as described above.

Other Supporting Calculations:
MEC Alternative 3 at the Line 6 Ammo Production (Inside Blast Radii) MRS

% of Total Energy Usage from Renewable Resources

- None identified

Hazardous Air Pollutants

- None identified

Refined Materials Use

- None identified. Specific mass of explosives for BIP has not been quantified, but is assumed to be a "refined material of undetermined but minor quantity".

Unrefined Materials Use

- None Identified

Tons of Non-Hazardous Waste

- None identified

Tons of Hazardous Waste

- None identified

% of Potential Waste Recycled

- N/A

Risks to On-Site Workers and from Transportation

- Based on SiteWise output
    - On-Site worker injuries or fatalities =
    - Transportation related injuries or fatalities =

Heavy Truck Trips through Residential Areas

- None identified

Project: GSR Pilot for IAAAP
Option or Alternative: MEC Alternative 3 at Line 6 Ammo Production (Inside Blast Radii)
Current Date: 4/10/2012

year	up-front cost	annual cost	present value of cost each year	cumulative cash flow	
		(no discounting)	2.3%	no discounting	2.3%
0	$332,510	$0	$332,510	$332,510	$332,510
1	$0	$0	$0	$332,510	$332,510
2	$0	$0	$0	$332,510	$332,510
3	$0	$0	$0	$332,510	$332,510
4	$0	$0	$0	$332,510	$332,510
5	$0	$3,105	$2,771	$335,615	$335,281
6	$0	$0	$0	$335,615	$335,281
7	$0	$0	$0	$335,615	$335,281
8	$0	$0	$0	$335,615	$335,281
9	$0	$0	$0	$335,615	$335,281
10	$0	$3,105	$2,473	$338,720	$337,755
11	$0	$0	$0	$338,720	$337,755
12	$0	$0	$0	$338,720	$337,755
13	$0	$0	$0	$338,720	$337,755
14	$0	$0	$0	$338,720	$337,755
15	$0	$3,105	$2,208	$341,825	$339,962
16	$0	$0	$0	$341,825	$339,962
17	$0	$0	$0	$341,825	$339,962
18	$0	$0	$0	$341,825	$339,962
19	$0	$0	$0	$341,825	$339,962
20	$0	$3,105	$1,970	$344,930	$341,933
21	$0	$0	$0	$344,930	$341,933
22	$0	$0	$0	$344,930	$341,933
23	$0	$0	$0	$344,930	$341,933
24	$0	$0	$0	$344,930	$341,933
25	$0	$3,105	$1,759	$348,035	$343,691
26	$0	$0	$0	$348,035	$343,691
27	$0	$0	$0	$348,035	$343,691
28	$0	$0	$0	$348,035	$343,691
29	$0	$0	$0	$348,035	$343,691
30	$0	$3,105	$1,570	$351,140	$345,261

*positive dollar value is a "cost", negative dollar value is a "savings"

Net Present Value (NPV)-> $345,261

Total of capital costs (undiscounted) -> $332,510
Total of annual costs (undiscounted) -> $18,630

GSR Team Calculations to Split Energy Results from SiteWise into "Direct" and "Indirect"
MEC Alternative 3 at the LL6 MRS

phase	Reported by SiteWise: activity	Reported by SiteWise: energy used (MMBTU)	Assigned by GSR Team from SiteWise Output: Scope 1 (direct) energy used (MMBTU)	Scope 2 (indirect) energy used (MMBTU)	Scope 3 (indirect) energy used (MMBTU)	Total Calculated by GSR Team
Removal Action Fieldwork ("Remedial Action Construction" tab)	Consumables	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	88.48	0.00	0.00	88.48	88.48
	Transportation-Equipment	0.00	0.00	0.00	0.00	0.00
	Equipment Use and Misc	0.00	0.00	0.00	0.00	0.00
	Residual Handling	0.00	0.00	0.00	0.00	0.00
	Sub-Total	88.48	0.00	0.00	88.48	88.48
total		88.48	0.00	0.00	88.48	88.48

Note: Electricity use reported by SiteWise Version 2.0 in units of kWh is "Direct Scope 1", meaning it is energy consumed at the location of the project. However, energy use associated with electricity reported by SiteWise in units of MMBtu is a life-cycle value which also includes a factor to account for energy used elsewhere required to generate the electricity ("Indirect Scope 2"). Here, 33% of the life-cycle value reported by SiteWise is considered to be "Scope 1" on-site energy use, and 67% is considered to be "Scope 2" energy used in electricity generation.

SiteWise Version 2.0 uses fuel energy values from U.S. Department of Energy, Argonne National Laboratory, Transportation Technology R&D Center, GREET 1.8d.1, Fuel-Cycle model, 2010. This version of the GREET model reports that for Gasoline and Diesel, approximately 19% of GHG emissions are upstream emissions (scope 3) and 81% are tailpipe emissions (scope 1). For this analysis, it is assumed that energy is used in these same proportions, and therefore the energy use reported by SiteWise is split between scope 3 and scope 1 in these ratios.

GSR Team Calculations to Split GHG Results from SiteWise into "Direct" and "Indirect"
MEC Alternative 3 at the LL6 MRS

phase	Reported by SiteWise		Assigned by GSR Team from SiteWise Output			Total Calculated by GSR Team
			Scope 1 (direct)	Scope 2 (indirect)	Scope 3 (indirect)	
	activity	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	
Removal Action Fieldwork ("Remedial Action Construction" tab)	Consumables	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	6.74	0.00	0.00	6.74	6.74
	Transportation-Equipment	0.00	0.00	0.00	0.00	0.00
	Equipment Use and Misc	0.00	0.00	0.00	0.00	0.00
	Residual Handling	0.00	0.00	0.00	0.00	0.00
	Sub-Total	6.74	0.00	0.00	6.74	6.74
Total		6.74	0.00	0.00	6.74	6.74

Note: CO2e reported by SiteWise Version 2.0 for electricity use is all associated with generation of the electricity ("Indirect Scope 2").

SiteWise Version 2.0 use fuel emission factors from U.S. Department of Energy, Argonne National Laboratory, Transportation Technology R&D Center, GREET 1.8d.1, Fuel-Cycle model, 2010. This version of the GREET model reports that for gasoline and diesel, approximately 19% of GHG emissions are upstream emissions (Scope 3) and 81% are tailpipe emissions (Scope 1). For this analysis, the GHG emissions reported by SiteWise are split between Scope 3 and Scope 1 in these ratios.

APPENDIX B-5:

MEC Alternative 2 at the Possible Demolition Site MRS

Appendix B-5
Assumptions for SiteWise Input and Other Calculations
Iowa Army Ammunition Plant GSR Evaluation:
MEC Alternative 2 at the Possible Demolition Site MRS

SiteWise "RA_MEC 2 PDS_NoFR_1" Directory

Appendix B-5 of this report includes notes for the footprinting of MEC Alternative 2 at the Possible Demolition Site (PDS) MRS. For the purposes of footprinting, this alternative will involve the following components:

- Security fencing and signage already in place around perimeter of the MRS (no additional fencing or signage needed)
- Annual O&M, including mowing along fence line and sign and fence inspection and maintenance, is the only activity with a quantifiable footprint for MEC Alternative 2 at the PDS MRS.

Unless otherwise noted, SiteWise inputs are based on the information described in Appendix A and the report text of the *Draft Feasibility Study (FS) Report* (dated November 2011). When information required for SiteWise input was not provided, reasonable assumptions were made (these assumptions are noted in the description of SiteWise input below).

The notes pertaining to SiteWise input are organized by the following tabs of the SiteWise input sheet:

- Annual O&M – Uses *"Remedial Action Operations"* tab of SiteWise input sheet

For each section of SiteWise, all the sections are listed, with pertinent information added only for those sections of the input sheet where data were added.

In some cases, small quantities of materials were not included in SiteWise input because the footprint of these items relative to the other materials used would be expected to be extremely minimal.

Other calculations done outside of SiteWise are then presented. These include the following:

- % of total energy from renewable resources
- Hazardous air pollutants
- Refined material use
- Unrefined material use
- Tons of non-hazardous waste
- Tons of hazardous waste
- % of Potential Waste Recycled
- Risks to on-site works and from transportation
- Heavy truck trips through residential areas

MEC Alternative 2 at PDS – Overview

Additional tables are attached which show how SiteWise outputs were split into “direct” and “indirect” energy use and greenhouse gas emissions. For definitions of direct and indirect energy use and emissions, please refer to section 2.2.2 of the evaluation report.

Cost calculations are based on cost information provided in Appendix A of the Draft FS. A summary cost sheet developed by the GSR Team is attached to this Appendix. Information regarding the cost calculations is as follows:

- The capital cost is $39,675 and occurs in year 0.
- The annual O&M cost is $5,279, occurring each year in years 1 through 30.
- The periodic cost is $3,105, occurring every five years in years 5, 10, 15, 20, 25, and 30.
- The sum of capital, annual, and periodic costs, non-discounted, is $216,675.
- To determine net present value (NPV), a 2.3 percent discount rate is applied to future costs, which is consistent with the discount rate applied in the Draft FS. NPV is calculated by discounting future costs to present-day dollars using the following equation:

$$PV = \frac{FV}{(1+i)^n} = C \times FV$$

PV is the present value
FV is the value in year “n” (i.e., future value)
i is the discount rate
C is the discount factor, which equals $1/(1+i)^n$

- The NPV calculated by the GSR Team is $165,922.

MEC Alternative 2 at PDS – Annual O&M

Scope of Work

Appendix A of the Draft FS indicates that one UXO Tech II will be needed for annual sign and fence inspection and maintenance. Based on information provided by the Project Team on the Step 5 call which took place on 11/21/11, UXO technicians will be travelling alone (i.e., no carpooling) and will travel 8 hours one-way to the site via a combination of air and car. The GSR Team assumes that this will equate to approximately 100 miles via car and 700 miles via plane per year for 30 years of O&M.

The cost information in Appendix A of the Draft FS indicates that a UXO Tech II will be needed for the following number of hours at each MRS (per year):

- CTA – 20 hrs
- LL6 – 20 hrs
- PDS – 10 hrs
- INDA – 40 hrs

Assuming that one UXO Tech will be utilized to inspect the signs and fences at all MRSs during a single trip to the site each year, the SiteWise inputs associated with travel to the local are for each MEC Alternative 2 at these four MRSs are divided by 4. Trips from the hotel to the site and back are assigned based on the number of hours spent at each MRS listed above, assuming 10 hour days. For PDS, this means one 12-mile round trip from the hotel to the site (one per day).

Appendix A of the Draft FS indicates that mowing will be required in the 10 ft^2 along 7,608 LF of the MRS fence line. The GSR Team assumes ~0.5 hours per acre * 1.7 acres to be mowed * mowing 2 times per year = 1.7 hours per year to mow area around PDS fence with large riding mower, such as those found at: http://www.deere.com/wps/dcom/en_US/products/equipment/front_mowers/front_mowers.page. The website indicates that the majority of these mowers run on diesel, and that each has a 16 gallon fuel tank that allows for 10 hours of runtime without refueling. Based on this statement, it is estimated that a mower of this size would have a consumption rate of 1.6 gallons per hour (16 gallons / 10 hours).

It is assumed that mowing at all 4 MRSs will be completed as a part of regular installation maintenance, and therefore a separate mob/demob for personnel is not included in the footprint for each MRS. It is also assumed that the mower is already owned and maintained by the installation, and mob/demob for the mower is not part of the footprint for each MRS. The footprint associated with mowing is therefore comprised only of the fuel usage required for mowing the specified area.

MEC Alternative 2 at PDS – Annual O&M

Input into "Remedial Action Operations" tab of SiteWise Input Sheet.xls

- Baseline Information
    - Remedial Action Operations Cost and Duration
        - Total remedial action operations cost ($) – leave blank in SiteWise
        - Duration of remedial action operations (unit time) – 1 yr for this GSR evaluation because we have multiplied input items by number of years as part of the input

- Material Production
    - Well Materials
    - Treatment Chemicals & Materials
    - Treatment Media
    - Construction Materials
    - Well Decommissioning
    - Bulk Material Quantities

- Transportation
    - Personnel Transportation – Road
        - Trip 1 – UXO Tech, car travel to and from site. Assume a car, gasoline. 100 miles one-way * 2 = 200 miles round trip / 4 (accounting for shared mobilization with other MRSs) = 50 miles, 1 trip per year for 30 years = 30 trips, 1 traveler.
        - Trip 2 – UXO Tech, daily car travel from hotel to site. Assume a car, gasoline. 12 miles round trip, 1 trip (for 1 day of field work at site, assuming 10 hour days) per year for 30 years = 30 trips, 1 traveler.
    - Personnel Transportation – Air
        - Trip 1 – UXO Tech, plane travel to and from site. 700 miles one-way * 2 = 1400 miles round trip / 4 (accounting for shared mobilization with other MRSs) = 350 miles, 1 traveler, 1 flight per year for 30 years = 30 flights.
    - Personnel Transportation – Rail
    - Equipment Transportation – Road
    - Equipment Transportation – Air
    - Equipment Transportation – Rail
    - Equipment Transportation – Water

- Equipment Use
    - Earthwork
    - Drilling
    - Trenching
    - Pump Operation
    - Diesel and Gasoline Pumps
    - Blower, Compressor, Mixer, and Other Equipment
    - Generators
    - Agricultural Equipment
    - Capping Equipment
    - Mixing Equipment
    - Internal Combustion Engines

        - Engine 1 – Large riding mower for mowing along MRS fence line. Assume diesel, fuel consumption rate of 1.6 gal/hr, 1.7 hours of operation per year * 30 years = 51 hours.
    - Other Fueled Equipment
    - Operator Labor
    - Laboratory Analysis
    - Other Known Onsite Activities

- Residual Handling
    - Residue Disposal/Recycling
    - Landfill Operations
    - Thermal/Catalytic Oxidizers

- Resource Consumption
    - Water Consumption
    - Onsite Land and Water Resource Consumption

Once SiteWise input is complete, go to "SiteWise_Input Sheet" for overall project and enter information (including Alternative File Name "MEC 2 PDS"). Then go to "Generate Alternative" tab and click button labeled "Click to generate alternative using previously entered alternative name". Copies of the input and output summary sheets for this alternative are now located in the directory titled "RA_MEC 2 PDS_NoFR_1". To store the "Remedial Action Operations.xls" calculation sheet showing detailed calculations, open it in the overall SiteWise project directory when the appropriate input sheet is open, then do a "save as" to put it in the directory for this alternative using a name that indicates "will not update". Then open that file and do "data->edit links" and break the links. If the input sheet for this alternative ever changes, then this calculation sheet needs to be re-saved.

To edit input parameters for this alternative, you must go back to the ORIGINAL SiteWise input sheet and import this alternative using the "Do you want to reload a previously saved remedial alternative in the SiteWise input sheet?" field on the "Site Info" tab. After making necessary changes to the input sheet, re-export the alternative by going to the "Generate Alternative" tab and clicking the button labeled "Click to replace an existing alternative with the same name". Update saved calculation sheets as described above.

Other Supporting Calculations:
MEC Alternative 2 at the Possible Demolition Site MRS

% of Total Energy Usage from Renewable Resources

- None identified

Hazardous Air Pollutants

- None identified

Refined Materials Use

- None Identified

Unrefined Materials Use

- None Identified

Tons of Non-Hazardous Waste

- None identified

Tons of Hazardous Waste

- None identified

% of Potential Waste Recycled

- N/A

Risks to On-Site Workers and from Transportation

- Based on SiteWise output
  - On-Site worker injuries or fatalities = 0
  - Transportation related injuries or fatalities = 0.0012

Heavy Truck Trips through Residential Areas

- None identified

Project: GSR Pilot for IAAAP
Option or Alternative: MEC Alternative 2 at Possible Demolition Site
Current Date: 4/10/2012

year	up-front cost	annual cost	present value of cost each year	cumulative cash flow	
		(no discounting)	2.3%	no discounting	2.3%
0	$39,675	$0	$39,675	$39,675	$39,675
1	$0	$5,279	$5,160	$44,954	$44,835
2	$0	$5,279	$5,044	$50,233	$49,880
3	$0	$5,279	$4,931	$55,512	$54,810
4	$0	$5,279	$4,820	$60,791	$59,631
5	$0	$8,384	$7,483	$69,175	$67,113
6	$0	$5,279	$4,606	$74,454	$71,719
7	$0	$5,279	$4,502	$79,733	$76,221
8	$0	$5,279	$4,401	$85,012	$80,622
9	$0	$5,279	$4,302	$90,291	$84,924
10	$0	$8,384	$6,679	$98,675	$91,603
11	$0	$5,279	$4,111	$103,954	$95,714
12	$0	$5,279	$4,018	$109,233	$99,732
13	$0	$5,279	$3,928	$114,512	$103,660
14	$0	$5,279	$3,840	$119,791	$107,500
15	$0	$8,384	$5,961	$128,175	$113,461
16	$0	$5,279	$3,669	$133,454	$117,130
17	$0	$5,279	$3,586	$138,733	$120,716
18	$0	$5,279	$3,506	$144,012	$124,222
19	$0	$5,279	$3,427	$149,291	$127,649
20	$0	$8,384	$5,320	$157,675	$132,969
21	$0	$5,279	$3,275	$162,954	$136,244
22	$0	$5,279	$3,201	$168,233	$139,445
23	$0	$5,279	$3,129	$173,512	$142,574
24	$0	$5,279	$3,059	$178,791	$145,633
25	$0	$8,384	$4,749	$187,175	$150,381
26	$0	$5,279	$2,923	$192,454	$153,304
27	$0	$5,279	$2,857	$197,733	$156,161
28	$0	$5,279	$2,793	$203,012	$158,954
29	$0	$5,279	$2,730	$208,291	$161,684
30	$0	$8,384	$4,238	$216,675	$165,922

*positive dollar value is a "cost", negative dollar value is a "savings"

Net Present Value (NPV)-> $165,922

Total of capital costs (undiscounted) -> $39,675
Total of annual costs (undiscounted) -> $177,000

GSR Team Calculations to Split Energy Results from SiteWise into "Direct" and "Indirect"
MEC Alternative 2 at the PDS MRS

phase	Reported by SiteWise: activity	Reported by SiteWise: energy used (MMBTU)	Assigned by GSR Team from SiteWise Output: Scope 1 (direct) energy used (MMBTU)	Scope 2 (indirect) energy used (MMBTU)	Scope 3 (indirect) energy used (MMBTU)	Total Calculated by GSR Team
Annual O&M ("Remedial Action Operations" tab)	Consumables	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	38.77	0.00	0.00	38.77	38.77
	Transportation-Equipment	0.00	0.00	0.00	0.00	0.00
	Equipment Use and Misc	11.09	8.98	0.00	2.11	11.09
	Residual Handling	0.00	0.00	0.00	0.00	0.00
	Sub-Total	49.85	8.98	0.00	40.87	49.85
total		49.85	8.98	0.00	40.87	49.85

Note: Electricity use reported by SiteWise Version 2.0 in units of kWh is "Direct Scope 1", meaning it is energy consumed at the location of the project. However, energy use associated with electricity reported by SiteWise in units of MMBtu is a life-cycle value which also includes a factor to account for energy used elsewhere required to generate the electricity ("Indirect Scope 2"). Here, 33% of the life-cycle value reported by SiteWise is considered to be "Scope 1" on-site energy use, and 67% is considered to be "Scope 2" energy used in electricity generation.

SiteWise Version 2.0 uses fuel energy values from U.S. Department of Energy, Argonne National Laboratory, Transportation Technology R&D Center, GREET 1.8d.1, Fuel-Cycle model, 2010. This version of the GREET model reports that for Gasoline and Diesel, approximately 19% of GHG emissions are upstream emissions (scope 3) and 81% are tailpipe emissions (scope 1). For this analysis, it is assumed that energy is used in these same proportions, and therefore the energy use reported by SiteWise is split between scope 3 and scope 1 in these ratios.

GSR Team Calculations to Split GHG Results from SiteWise into "Direct" and "Indirect"
MEC Alternative 2 at the PDS MRS

phase	Reported by SiteWise: activity	Reported by SiteWise: GHG emitted (metric tons CO2e)	Assigned by GSR Team from SiteWise Output: Scope 1 (direct) GHG emitted (metric tons CO2e)	Scope 2 (indirect) GHG emitted (metric tons CO2e)	Scope 3 (indirect) GHG emitted (metric tons CO2e)	Total Calculated by GSR Team
Annual O&M ("Remedial Action Operations" tab)	Consumables	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	2.94	0.00	0.00	2.94	2.94
	Transportation-Equipment	0.00	0.00	0.00	0.00	0.00
	Equipment Use and Misc	1.01	0.82	0.00	0.19	1.01
	Residual Handling	0.00	0.00	0.00	0.00	0.00
	Sub-Total	3.96	0.82	0.00	3.14	3.96
Total		3.96	0.82	0.00	3.14	3.96

Note: CO2e reported by SiteWise Version 2.0 for electricity use is all associated with generation of the electricity ("Indirect Scope 2").

SiteWise Version 2.0 use fuel emission factors from U.S. Department of Energy, Argonne National Laboratory, Transportation Technology R&D Center, GREET 1.8d.1, Fuel-Cycle model, 2010. This version of the GREET model reports that for gasoline and diesel, approximately 19% of GHG emissions are upstream emissions (Scope 3) and 81% are tailpipe emissions (Scope 1). For this analysis, the GHG emissions reported by SiteWise are split between Scope 3 and Scope 1 in these ratios.

APPENDIX B-6:

MEC Alternative 3 at the Possible Demolition Site MRS

Appendix B-6
Assumptions for SiteWise Input and Other Calculations
Iowa Army Ammunition Plant GSR Evaluation:
MEC Alternative 3 at the Possible Demolition Site MRS

SiteWise "RA_MEC 3 PDS_NoFR_1" Directory

Appendix B-6 of this report includes notes for the footprinting of MEC Alternative 3 at the Possible Demolition Site (PDS) MRS. For the purposes of footprinting, this alternative will involve the following components:

- MEC subsurface clearance over the entire MRS
- Previous RI geophysical data will be used for intrusive investigation
- Intrusive investigation (Analog mag, flag, and dig) of 48 acres using Schonstedt GA-52Cx, polyvinyl chloride pin flags, and Trimble RTK GPS
- Two 7-person UXO teams and two additional UXO specialists conducting field work for 60 days
- Assume approximately 200 anomalies/acre, and a production rate of 160 digs per day, which equates to 1.25 days per acre to conduct mag, flag, and dig (GSR Team assumes 10 hour days based on labor hours per acre provided in Draft FS Table A-5-3)
- Assume demilitarization of 40 MD items per acre
- Assume one BIP/consolidated shot per 1000 digs

The specific mass of explosives for BIP has not been quantified, but is assumed to be a "refined material of undetermined but minor quantity".

Unless otherwise noted, SiteWise inputs are based on the information described in Appendix A and the report text of the *Draft Feasibility Study (FS) Report* (dated November 2011). When information required for SiteWise input was not provided, reasonable assumptions were made (these assumptions are noted in the description of SiteWise input below).

The notes pertaining to SiteWise input are organized by the following tabs of the SiteWise input sheet:

- Removal Action Fieldwork – Uses *"Remedial Action Construction"* tab of SiteWise input sheet

For each section of SiteWise, all the sections are listed, with pertinent information added only for those sections of the input sheet where data were added.

In some cases, small quantities of materials were not included in SiteWise input because the footprint of these items relative to the other materials used would be expected to be extremely minimal.

Other calculations done outside of SiteWise are then presented. These include the following:

- % of total energy from renewable resources
- Hazardous air pollutants
- Refined material use
- Unrefined material use

MEC Alternative 3 at PDS – Overview

- Tons of non-hazardous waste
- Tons of hazardous waste
- % of Potential Waste Recycled
- Risks to on-site works and from transportation
- Heavy truck trips through residential areas

Additional tables are attached which show how SiteWise outputs were split into "direct" and "indirect" energy use and greenhouse gas emissions. For definitions of direct and indirect energy use and emissions, please refer to section 2.2.2 of the evaluation report.

Cost calculations are based on cost information provided in Appendix A of the Draft FS. A summary cost sheet developed by the GSR Team is attached to this Appendix. Information regarding the cost calculations is as follows:

- The capital cost is $1,399,495 and occurs in year 0.

- The annual O&M cost is $0.

- The periodic cost is $3,105, occurring every five years in years 5, 10, 15, 20, 25, and 30.

- The sum of capital, annual, and periodic costs, non-discounted, is $1,418,125.

- To determine net present value (NPV), a 2.3 percent discount rate is applied to future costs, which is consistent with the discount rate applied in the Draft FS. NPV is calculated by discounting future costs to present-day dollars using the following equation:

$$PV = \frac{FV}{(1+i)^n} = C \times FV$$

PV is the present value
FV is the value in year "n" (i.e., future value)
i is the discount rate
C is the discount factor, which equals $1/(1+i)^n$

- The NPV calculated by the GSR Team is $1,412,246.

MEC Alternative 3 at PDS – Removal Action Fieldwork

Scope of Work

Appendix A of the Draft FS indicates 60 days of intrusive investigation (analog mag, flag, and dig), assuming approximately 200 anomalies per acre, and a production rate of 160 digs per day, which equates to 1.25 days per acre to conduct mag, flag, and dig. Appendix A also appears to (indirectly) indicate 10 hour days, based on labor hours per acre provided in Table A-5-3. The Draft FS assumes one BIP/consolidated shot per 1000 digs and demilitarization of 40 MD items per acre.

It is assumed that intrusive investigations for the various MRSs at IAAAP will be conducted separately (because of their long duration relative to the fencing/signage installation in Alternative 2), and therefore mob/demob footprints are not shared among the MEC Alternative 3 MRSs.

The Draft FS indicates that potential MEC items would be removed to a depth of 2 feet bgs using manual removal techniques (e.g., shovels, hand equipment), no use of heavy machinery is specified. Weights and quantities of materials are not further specified, and are assumed to be minimal (as is shipping of equipment). The GSR Team makes the assumptions indicated below in the SiteWise inputs section.

The following personnel will travel to the site for fieldwork:

- Two 7-person UXO dig teams for 60 days
- SUXOS and UXOQCS/SO for removal activities, MEC disposal evolutions, and MPPEH inspections
- Assume that Project Manager to provide project oversight and GIS specialist to maintain GIS anomaly tracking database will not be travelling to the site as a part of field activities (consistent with 16 field personnel noted in the "Per Diem" listing on Table A-5-3). No footprint is calculated for these two personnel.

Based on information provided by the Project Team on the Step 5 call which took place on 11/21/11, the 16 UXO technicians will be travelling alone (i.e., no carpooling) and will travel 8 hours one-way to the site via a combination of air and car. The GSR Team assumes that this will equate to approximately 100 miles via car and 700 miles via plane.

It is further assumed that UXO personnel will be staying in a nearby hotel in Burlington, IA for the extent of field work (60 round trips from the hotel to the site and back for each person). The equipment listed in Table A-5-3 includes 6 pick-up trucks per day for the duration of the remedial action (60 days), presumably for the UXO personnel. It is assumed that these will be used both for personnel transport from the hotel to the site and back and for on-site transport. Assuming that a round trip from the hotel to the site is ~12 miles, and an additional 3 miles per day of on-site transport, the GSR Team assumes a total of 15 miles per truck per day. It is also assumed that workers will carpool 2 or 3 people per vehicle (16 UXO personnel / 6 trucks = average of 2.67 passengers per trip).

Unlike the DGM subsurface clearance, Appendix A indicates that no additional field technicians will be needed for the analog subsurface clearance.

MEC Alternative 3 at PDS – Removal Action Fieldwork

Input into "Remedial Action Construction" tab of SiteWise Input Sheet.xls

- Baseline Information
  - Remedial Action Construction Cost
    - Total remedial action construction cost ($) – leave blank in SiteWise

- Material Production
  - Well Materials
  - Treatment Chemicals & Materials
  - Treatment Media
  - Construction Materials
  - Well Decommissioning
  - Bulk Material Quantities

- Transportation
  - Personnel Transportation – Road
    - Trip 1 – UXO Techs, car travel to and from site. Assume a car, gasoline. 100 miles one-way * 2 = 200 miles round trip, 16 trip (since there are 16 UXO personnel travelling separately), 1 traveler per car.
    - Trip 2 – UXO Techs, daily travel from hotel to site and on-site. Assume light trucks, gasoline. 12 miles round trip + 3 miles on-site = 15 miles per day, 60 trips (for each day of field work at site) * 6 trucks = 360 trips, 2.67 travelers per truck (16 UXO techs / 6 trucks).
  - Personnel Transportation – Air
    - Trip 1 – UXO Tech, plane travel to and from site. 700 miles one-way * 2 = 1400 miles round trip, 16 traveler, 1 flight each.
  - Personnel Transportation – Rail
  - Equipment Transportation – Road
  - Equipment Transportation – Air
  - Equipment Transportation – Rail
  - Equipment Transportation – Water

- Equipment Use
  - Earthwork
  - Drilling
  - Trenching
  - Pump Operation
  - Diesel and Gasoline Pumps
  - Blower, Compressor, Mixer, and Other Equipment
  - Generators
  - Agricultural Equipment
  - Capping Equipment
  - Mixing Equipment
  - Internal Combustion Engines
  - Other Fueled Equipment
  - Operator Labor
  - Laboratory Analysis
  - Other Known Onsite Activities

- Residual Handling
    - Residue Disposal/Recycling
    - Landfill Operations
    - Thermal/Catalytic Oxidizers

- Resource Consumption
    - Water Consumption
    - Onsite Land and Water Resource Consumption

Once SiteWise input is complete, go to "SiteWise_Input Sheet" for overall project and enter information (including Alternative File Name "MEC 3 PDS"). Then go to "Generate Alternative" tab and click button labeled "Click to generate alternative using previously entered alternative name". Copies of the input and output summary sheets for this alternative are now located in the directory titled "RA_MEC 3 PDS_NoFR_1". To store the "Remedial Action Construction.xls" calculation sheet showing detailed calculations, open it in the overall SiteWise project directory when the appropriate input sheet is open, then do a "save as" to put it in the directory for this alternative using a name that indicates "will not update". Then open that file and do "data->edit links" and break the links. If the input sheet for this alternative ever changes, then this calculation sheet needs to be re-saved.

To edit input parameters for this alternative, you must go back to the ORIGINAL SiteWise input sheet and import this alternative using the "Do you want to reload a previously saved remedial alternative in the SiteWise input sheet?" field on the "Site Info" tab. After making necessary changes to the input sheet, re-export the alternative by going to the "Generate Alternative" tab and clicking the button labeled "Click to replace an existing alternative with the same name". Update saved calculation sheets as described above.

Other Supporting Calculations: MEC Alternative 3 at the Possible Demolition Site MRS

% of Total Energy Usage from Renewable Resources

- None identified

Hazardous Air Pollutants

- None identified

Refined Materials Use

- None identified. Specific mass of explosives for BIP has not been quantified, but is assumed to be a "refined material of undetermined but minor quantity".

Unrefined Materials Use

- None identified

Tons of Non-Hazardous Waste

- None identified

Tons of Hazardous Waste

- None identified

% of Potential Waste Recycled

- N/A

Risks to On-Site Workers and from Transportation

- Based on SiteWise output
  - On-Site worker injuries or fatalities = 0
  - Transportation related injuries or fatalities = 0.0112

Heavy Truck Trips through Residential Areas

- None identified

Project: GSR Pilot for IAAAP
Option or Alternative: MEC Alternative 3 at Possible Demolition Site
Current Date: 4/10/2012

year	up-front cost	annual cost	present value of cost each year	cumulative cash flow	
		(no discounting)	2.3%	no discounting	2.3%
0	$1,399,495	$0	$1,399,495	$1,399,495	$1,399,495
1	$0	$0	$0	$1,399,495	$1,399,495
2	$0	$0	$0	$1,399,495	$1,399,495
3	$0	$0	$0	$1,399,495	$1,399,495
4	$0	$0	$0	$1,399,495	$1,399,495
5	$0	$3,105	$2,771	$1,402,600	$1,402,266
6	$0	$0	$0	$1,402,600	$1,402,266
7	$0	$0	$0	$1,402,600	$1,402,266
8	$0	$0	$0	$1,402,600	$1,402,266
9	$0	$0	$0	$1,402,600	$1,402,266
10	$0	$3,105	$2,473	$1,405,705	$1,404,740
11	$0	$0	$0	$1,405,705	$1,404,740
12	$0	$0	$0	$1,405,705	$1,404,740
13	$0	$0	$0	$1,405,705	$1,404,740
14	$0	$0	$0	$1,405,705	$1,404,740
15	$0	$3,105	$2,208	$1,408,810	$1,406,947
16	$0	$0	$0	$1,408,810	$1,406,947
17	$0	$0	$0	$1,408,810	$1,406,947
18	$0	$0	$0	$1,408,810	$1,406,947
19	$0	$0	$0	$1,408,810	$1,406,947
20	$0	$3,105	$1,970	$1,411,915	$1,408,918
21	$0	$0	$0	$1,411,915	$1,408,918
22	$0	$0	$0	$1,411,915	$1,408,918
23	$0	$0	$0	$1,411,915	$1,408,918
24	$0	$0	$0	$1,411,915	$1,408,918
25	$0	$3,105	$1,759	$1,415,020	$1,410,676
26	$0	$0	$0	$1,415,020	$1,410,676
27	$0	$0	$0	$1,415,020	$1,410,676
28	$0	$0	$0	$1,415,020	$1,410,676
29	$0	$0	$0	$1,415,020	$1,410,676
30	$0	$3,105	$1,570	$1,418,125	$1,412,246

*positive dollar value is a "cost", negative dollar value is a "savings"

Net Present Value (NPV)-> $1,412,246

Total of capital costs (undiscounted) -> $1,399,495
Total of annual costs (undiscounted) -> $18,630

GSR Team Calculations to Split Energy Results from SiteWise into "Direct" and "Indirect"
MEC Alternative 3 at the PDS MRS

phase	Reported by SiteWise: activity	Reported by SiteWise: energy used (MMBTU)	Assigned by GSR Team from SiteWise Output: Scope 1 (direct) energy used (MMBTU)	Scope 2 (indirect) energy used (MMBTU)	Scope 3 (indirect) energy used (MMBTU)	Total Calculated by GSR Team
Removal Action Fieldwork ("Remedial Action Construction" tab)	Consumables	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	116.56	0.00	0.00	116.56	116.56
	Transportation-Equipment	0.00	0.00	0.00	0.00	0.00
	Equipment Use and Misc	0.00	0.00	0.00	0.00	0.00
	Residual Handling	0.00	0.00	0.00	0.00	0.00
	Sub-Total	116.56	0.00	0.00	116.56	116.56
total		116.56	0.00	0.00	116.56	116.56

Note: Electricity use reported by SiteWise Version 2.0 in units of kWh is "Direct Scope 1", meaning it is energy consumed at the location of the project. However, energy use associated with electricity reported by SiteWise in units of MMBtu is a life-cycle value which also includes a factor to account for energy used elsewhere required to generate the electricity ("Indirect Scope 2"). Here, 33% of the life-cycle value reported by SiteWise is considered to be "Scope 1" on-site energy use, and 67% is considered to be "Scope 2" energy used in electricity generation.

SiteWise Version 2.0 uses fuel energy values from U.S. Department of Energy, Argonne National Laboratory, Transportation Technology R&D Center, GREET 1.8d.1, Fuel-Cycle model, 2010. This version of the GREET model reports that for Gasoline and Diesel, approximately 19% of GHG emissions are upstream emissions (scope 3) and 81% are tailpipe emissions (scope 1). For this analysis, it is assumed that energy is used in these same proportions, and therefore the energy use reported by SiteWise is split between scope 3 and scope 1 in these ratios.

GSR Team Calculations to Split GHG Results from SiteWise into "Direct" and "Indirect"
MEC Alternative 3 at the PDS MRS

phase	Reported by SiteWise		Assigned by GSR Team from SiteWise Output			Total Calculated by GSR Team
			Scope 1 (direct)	Scope 2 (indirect)	Scope 3 (indirect)	
	activity	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	
Removal Action Fieldwork ("Remedial Action Construction" tab)	Consumables	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	8.96	0.00	0.00	8.96	8.96
	Transportation-Equipment	0.00	0.00	0.00	0.00	0.00
	Equipment Use and Misc	0.00	0.00	0.00	0.00	0.00
	Residual Handling	0.00	0.00	0.00	0.00	0.00
	Sub-Total	8.96	0.00	0.00	8.96	8.96
Total		8.96	0.00	0.00	8.96	8.96

Note: CO2e reported by SiteWise Version 2.0 for electricity use is all associated with generation of the electricity ("Indirect Scope 2").

SiteWise Version 2.0 use fuel emission factors from U.S. Department of Energy, Argonne National Laboratory, Transportation Technology R&D Center, GREET 1.8d.1, Fuel-Cycle model, 2010. This version of the GREET model reports that for gasoline and diesel, approximately 19% of GHG emissions are upstream emissions (Scope 3) and 81% are tailpipe emissions (Scope 1). For this analysis, the GHG emissions reported by SiteWise are split between Scope 3 and Scope 1 in these ratios.

APPENDIX B-7:

MEC Alternative 2 at the Incendiary Disposal Area MRS

Appendix B-7
Assumptions for SiteWise Input and Other Calculations
Iowa Army Ammunition Plant GSR Evaluation:
MEC Alternative 2 at the Incendiary Disposal Area MRS

SiteWise "RA_MEC 2 INDA_NoFR_1" Directory

Appendix B-7 of this report includes notes for the footprinting of MEC Alternative 2 at the Incendiary Disposal Area (INDA) MRS. For the purposes of footprinting, this alternative will involve the following components:

- Security fencing and signage already in place around perimeter of the MRS (no additional fencing or signage needed)
- Annual O&M, including mowing along fence line and sign and fence inspection and maintenance, is the only activity with a quantifiable footprint for MEC Alternative 2 at the INDA MRS.

Unless otherwise noted, SiteWise inputs are based on the information described in Appendix A and the report text of the *Draft Feasibility Study (FS) Report* (dated November 2011). When information required for SiteWise input was not provided, reasonable assumptions were made (these assumptions are noted in the description of SiteWise input below).

The notes pertaining to SiteWise input are organized by the following tabs of the SiteWise input sheet:

- Annual O&M – Uses *"Remedial Action Operations"* tab of SiteWise input sheet

For each section of SiteWise, all the sections are listed, with pertinent information added only for those sections of the input sheet where data were added.

In some cases, small quantities of materials were not included in SiteWise input because the footprint of these items relative to the other materials used would be expected to be extremely minimal.

Other calculations done outside of SiteWise are then presented. These include the following:

- % of total energy from renewable resources
- Hazardous air pollutants
- Refined material use
- Unrefined material use
- Tons of non-hazardous waste
- Tons of hazardous waste
- % of Potential Waste Recycled
- Risks to on-site works and from transportation
- Heavy truck trips through residential areas

MEC Alternative 2 at INDA – Overview

Additional tables are attached which show how SiteWise outputs were split into "direct" and "indirect" energy use and greenhouse gas emissions. For definitions of direct and indirect energy use and emissions, please refer to section 2.2.2 of the evaluation report.

Cost calculations are based on cost information provided in Appendix A of the Draft FS. A summary cost sheet developed by the GSR Team is attached to this Appendix. Information regarding the cost calculations is as follows:

- The capital cost is $39,675 and occurs in year 0.

- The annual O&M cost is $5,256, occurring each year in years 1 through 30.

- The periodic cost is $3,105, occurring every five years in years 5, 10, 15, 20, 25, and 30.

- The sum of capital, annual, and periodic costs, non-discounted, is $215,985.

- To determine net present value (NPV), a 2.3 percent discount rate is applied to future costs, which is consistent with the discount rate applied in the Draft FS. NPV is calculated by discounting future costs to present-day dollars using the following equation:

$$PV = \frac{FV}{(1+i)^n} = C \times FV$$

  PV is the present value
  FV is the value in year "n" (i.e., future value)
  i is the discount rate
  C is the discount factor, which equals $1/(1+i)^n$

- The NPV calculated by the GSR Team is $165,427.

MEC Alternative 2 at INDA – Annual O&M

Scope of Work

Appendix A of the Draft FS indicates that one UXO Tech II will be needed for annual sign and fence inspection and maintenance. Based on information provided by the Project Team on the Step 5 call which took place on 11/21/11, UXO technicians will be travelling alone (i.e., no carpooling) and will travel 8 hours one-way to the site via a combination of air and car. The GSR Team assumes that this will equate to approximately 100 miles via car and 700 miles via plane per year for 30 years of O&M.

The cost information in Appendix A of the Draft FS indicates that a UXO Tech II will be needed for the following number of hours at each MRS (per year):

- CTA – 20 hrs
- LL6 – 20 hrs
- PDS – 10 hrs
- INDA – 40 hrs

Assuming that one UXO Tech will be utilized to inspect the signs and fences at all MRSs during a single trip to the site each year, the SiteWise inputs associated with travel to the local are for each MEC Alternative 2 at these four MRSs are divided by 4. Trips from the hotel to the site and back are assigned based on the number of hours spent at each MRS listed above, assuming 10 hour days. For INDA, this means four 12-mile round trips from the hotel to the site (one per day).

Appendix A of the Draft FS indicates that mowing will be required in the 10 ft^2 along 5,345 LF of the MRS fence line. The GSR Team assumes ~0.5 hours per acre * 1.2 acres to be mowed * mowing 2 times per year = 1.2 hours per year to mow area around PDS fence with large riding mower, such as those found at: http://www.deere.com/wps/dcom/en_US/products/equipment/front_mowers/front_mowers.page. The website indicates that the majority of these mowers run on diesel, and that each has a 16 gallon fuel tank that allows for 10 hours of runtime without refueling. Based on this statement, it is estimated that a mower of this size would have a consumption rate of 1.6 gallons per hour (16 gallons / 10 hours).

It is assumed that mowing at all 4 MRSs will be completed as a part of regular installation maintenance, and therefore a separate mob/demob for personnel is not included in the footprint for each MRS. It is also assumed that the mower is already owned and maintained by the installation, and mob/demob for the mower is not part of the footprint for each MRS. The footprint associated with mowing is therefore comprised only of the fuel usage required for mowing the specified area.

MEC Alternative 2 at INDA – Annual O&M

<u>Input into "Remedial Action Operations" tab of SiteWise Input Sheet.xls</u>

- Baseline Information
    - Remedial Action Operations Cost and Duration
        - Total remedial action operations cost ($) – leave blank in SiteWise
        - Duration of remedial action operations (unit time) – 1 yr for this GSR evaluation because we have multiplied input items by number of years as part of the input

- Material Production
    - Well Materials
    - Treatment Chemicals & Materials
    - Treatment Media
    - Construction Materials
    - Well Decommissioning
    - Bulk Material Quantities

- Transportation
    - Personnel Transportation – Road
        - Trip 1 – UXO Tech, car travel to and from site. Assume a car, gasoline. 100 miles one-way * 2 = 200 miles round trip / 4 (accounting for shared mobilization with other MRSs) = 50 miles, 1 trip per year for 30 years = 30 trips, 1 traveler.
        - Trip 2 – UXO Tech, daily car travel from hotel to site. Assume a car, gasoline. 12 miles round trip, 4 trips (for 4 days of field work at site, assuming 10 hour days) per year for 30 years = 120 trips, 1 traveler.
    - Personnel Transportation – Air
        - Trip 1 – UXO Tech, plane travel to and from site. 700 miles one-way * 2 = 1400 miles round trip / 4 (accounting for shared mobilization with other MRSs) = 350 miles, 1 traveler, 1 flight per year for 30 years = 30 flights.
    - Personnel Transportation – Rail
    - Equipment Transportation – Road
    - Equipment Transportation – Air
    - Equipment Transportation – Rail
    - Equipment Transportation – Water

- Equipment Use
    - Earthwork
    - Drilling
    - Trenching
    - Pump Operation
    - Diesel and Gasoline Pumps
    - Blower, Compressor, Mixer, and Other Equipment
    - Generators
    - Agricultural Equipment
    - Capping Equipment
    - Mixing Equipment
    - Internal Combustion Engines

        - Engine 1 – Large riding mower for mowing along MRS fence line. Assume diesel, fuel consumption rate of 1.6 gal/hr, 1.2 hours of operation per year * 30 years = 36 hours.
    - Other Fueled Equipment
    - Operator Labor
    - Laboratory Analysis
    - Other Known Onsite Activities

- Residual Handling
    - Residue Disposal/Recycling
    - Landfill Operations
    - Thermal/Catalytic Oxidizers

- Resource Consumption
    - Water Consumption
    - Onsite Land and Water Resource Consumption

Once SiteWise input is complete, go to “SiteWise_Input Sheet” for overall project and enter information (including Alternative File Name “MEC 2 INDA”). Then go to “Generate Alternative” tab and click button labeled “Click to generate alternative using previously entered alternative name”. Copies of the input and output summary sheets for this alternative are now located in the directory titled “RA_MEC 2 INDA_NoFR_1”. To store the “Remedial Action Operations.xls” calculation sheet showing detailed calculations, open it in the overall SiteWise project directory when the appropriate input sheet is open, then do a “save as” to put it in the directory for this alternative using a name that indicates “will not update”. Then open that file and do “data->edit links” and break the links. If the input sheet for this alternative ever changes, then this calculation sheet needs to be re-saved.

To edit input parameters for this alternative, you must go back to the ORIGINAL SiteWise input sheet and import this alternative using the “Do you want to reload a previously saved remedial alternative in the SiteWise input sheet?” field on the “Site Info” tab. After making necessary changes to the input sheet, re-export the alternative by going to the “Generate Alternative” tab and clicking the button labeled “Click to replace an existing alternative with the same name”. Update saved calculation sheets as described above.

Other Supporting Calculations:
MEC Alternative 2 at the Incendiary Disposal Area MRS

% of Total Energy Usage from Renewable Resources

- None identified

Hazardous Air Pollutants

- None identified

Refined Materials Use

- None identified

Unrefined Materials Use

- None identified

Tons of Non-Hazardous Waste

- None identified

Tons of Hazardous Waste

- None identified

% of Potential Waste Recycled

- N/A

Risks to On-Site Workers and from Transportation

- Based on SiteWise output
    - On-Site worker injuries or fatalities = 0
    - Transportation related injuries or fatalities = 0.0019

Heavy Truck Trips through Residential Areas

- None identified

Project: GSR Pilot for IAAAP
Option or Alternative: MEC Alternative 2 at Incendiary Disposal Area
Current Date: 4/10/2012

year	up-front cost	annual cost	present value of cost each year	cumulative cash flow	
		(no discounting)	2.3%	no discounting	2.3%
0	$39,675	$0	$39,675	$39,675	$39,675
1	$0	$5,256	$5,138	$44,931	$44,813
2	$0	$5,256	$5,022	$50,187	$49,835
3	$0	$5,256	$4,909	$55,443	$54,745
4	$0	$5,256	$4,799	$60,699	$59,544
5	$0	$8,361	$7,462	$69,060	$67,006
6	$0	$5,256	$4,586	$74,316	$71,592
7	$0	$5,256	$4,483	$79,572	$76,074
8	$0	$5,256	$4,382	$84,828	$80,456
9	$0	$5,256	$4,283	$90,084	$84,739
10	$0	$8,361	$6,660	$98,445	$91,400
11	$0	$5,256	$4,093	$103,701	$95,493
12	$0	$5,256	$4,001	$108,957	$99,493
13	$0	$5,256	$3,911	$114,213	$103,404
14	$0	$5,256	$3,823	$119,469	$107,227
15	$0	$8,361	$5,945	$127,830	$113,172
16	$0	$5,256	$3,653	$133,086	$116,825
17	$0	$5,256	$3,571	$138,342	$120,396
18	$0	$5,256	$3,491	$143,598	$123,886
19	$0	$5,256	$3,412	$148,854	$127,298
20	$0	$8,361	$5,306	$157,215	$132,604
21	$0	$5,256	$3,260	$162,471	$135,864
22	$0	$5,256	$3,187	$167,727	$139,051
23	$0	$5,256	$3,115	$172,983	$142,167
24	$0	$5,256	$3,045	$178,239	$145,212
25	$0	$8,361	$4,736	$186,600	$149,948
26	$0	$5,256	$2,910	$191,856	$152,858
27	$0	$5,256	$2,845	$197,112	$155,702
28	$0	$5,256	$2,781	$202,368	$158,483
29	$0	$5,256	$2,718	$207,624	$161,201
30	$0	$8,361	$4,227	$215,985	$165,427

*positive dollar value is a "cost", negative dollar value is a "savings"

Net Present Value (NPV)-> $165,427

Total of capital costs (undiscounted) -> $39,675
Total of annual costs (undiscounted) -> $176,310

GSR Team Calculations to Split Energy Results from SiteWise into "Direct" and "Indirect"
MEC Alternative 2 at the INDA MRS

phase	Reported by SiteWise		Assigned by GSR Team from SiteWise Output			Total Calculated by GSR Team
			Scope 1 (direct)	Scope 2 (indirect)	Scope 3 (indirect)	
	activity	energy used (MMBTU)	energy used (MMBTU)	energy used (MMBTU)	energy used (MMBTU)	
Annual O&M (“Remedial Action Operations” tab)	Consumables	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	43.94	0.00	0.00	43.94	43.94
	Transportation-Equipment	0.00	0.00	0.00	0.00	0.00
	Equipment Use and Misc	7.82	6.34	0.00	1.49	7.82
	Residual Handling	0.00	0.00	0.00	0.00	0.00
	Sub-Total	51.77	6.34	0.00	45.43	51.77
total		51.77	6.34	0.00	45.43	51.77

Note: Electricity use reported by SiteWise Version 2.0 in units of kWh is “Direct Scope 1”, meaning it is energy consumed at the location of the project. However, energy use associated with electricity reported by SiteWise in units of MMBtu is a life-cycle value which also includes a factor to account for energy used elsewhere required to generate the electricity (“Indirect Scope 2”). Here, 33% of the life-cycle value reported by SiteWise is considered to be "Scope 1" on-site energy use, and 67% is considered to be "Scope 2" energy used in electricity generation.

SiteWise Version 2.0 uses fuel energy values from U.S. Department of Energy, Argonne National Laboratory, Transportation Technology R&D Center, GREET 1.8d.1, Fuel-Cycle model, 2010. This version of the GREET model reports that for Gasoline and Diesel, approximately 19% of GHG emissions are upstream emissions (scope 3) and 81% are tailpipe emissions (scope 1). For this analysis, it is assumed that energy is used in these same proportions, and therefore the energy use reported by SiteWise is split between scope 3 and scope 1 in these ratios.

GSR Team Calculations to Split GHG Results from SiteWise into "Direct" and "Indirect"
MEC Alternative 2 at the INDA MRS

phase	Reported by SiteWise		Assigned by GSR Team from SiteWise Output			Total Calculated by GSR Team
			Scope 1 (direct)	Scope 2 (indirect)	Scope 3 (indirect)	
	activity	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	
Annual O&M ("Remedial Action Operations" tab)	Consumables	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	3.36	0.00	0.00	3.36	3.36
	Transportation-Equipment	0.00	0.00	0.00	0.00	0.00
	Equipment Use and Misc	0.72	0.58	0.00	0.14	0.72
	Residual Handling	0.00	0.00	0.00	0.00	0.00
	Sub-Total	4.07	0.58	0.00	3.49	4.07
Total		4.07	0.58	0.00	3.49	4.07

Note: CO2e reported by SiteWise Version 2.0 for electricity use is all associated with generation of the electricity ("Indirect Scope 2").

SiteWise Version 2.0 use fuel emission factors from U.S. Department of Energy, Argonne National Laboratory, Transportation Technology R&D Center, GREET 1.8d.1, Fuel-Cycle model, 2010. This version of the GREET model reports that for gasoline and diesel, approximately 19% of GHG emissions are upstream emissions (Scope 3) and 81% are tailpipe emissions (Scope 1). For this analysis, the GHG emissions reported by SiteWise are split between Scope 3 and Scope 1 in these ratios.

APPENDIX B-8:

MEC Alternative 3 at the Incendiary Disposal Area MRS

Appendix B-8
Assumptions for SiteWise Input and Other Calculations
Iowa Army Ammunition Plant GSR Evaluation:
MEC Alternative 3 at the Incendiary Disposal Area MRS

SiteWise "RA_MEC 3 INDA_NoFR_1" Directory

Appendix B-8 of this report includes notes for the footprinting of MEC Alternative 3 at the Incendiary Disposal Area (INDA) MRS. For the purposes of footprinting, this alternative will involve the following components:

- MEC subsurface clearance over the entire MRS
- Previous RI geophysical data will be used for intrusive investigation
- Intrusive investigation (Analog mag, flag, and dig) of 34 acres using Schonstedt GA-52Cx, polyvinyl chloride pin flags, and Trimble RTK GPS
- Two 7-person UXO teams and two additional UXO specialists conducting field work for 42.5 days
- Assume approximately 200 anomalies/acre, and a production rate of 160 digs per day, which equates to 1.25 days per acre to conduct mag, flag, and dig (GSR Team assumes 10 hour days based on labor hours per acre provided in Draft FS Table A-5-3)
- Assume demilitarization of 40 MD items per acre
- Assume one BIP/consolidated shot per 1000 digs

The specific mass of explosives for BIP has not been quantified, but is assumed to be a "refined material of undetermined but minor quantity".

Unless otherwise noted, SiteWise inputs are based on the information described in Appendix A and the report text of the *Draft Feasibility Study (FS) Report* (dated November 2011). When information required for SiteWise input was not provided, reasonable assumptions were made (these assumptions are noted in the description of SiteWise input below).

The notes pertaining to SiteWise input are organized by the following tabs of the SiteWise input sheet:

- Removal Action Fieldwork – Uses *"Remedial Action Construction"* tab of SiteWise input sheet

For each section of SiteWise, all the sections are listed, with pertinent information added only for those sections of the input sheet where data were added.

In some cases, small quantities of materials were not included in SiteWise input because the footprint of these items relative to the other materials used would be expected to be extremely minimal.

Other calculations done outside of SiteWise are then presented. These include the following:

- % of total energy from renewable resources
- Hazardous air pollutants
- Refined material use
- Unrefined material use

MEC Alternative 3 at INDA – Overview

- Tons of non-hazardous waste
- Tons of hazardous waste
- % of Potential Waste Recycled
- Risks to on-site works and from transportation
- Heavy truck trips through residential areas

Additional tables are attached which show how SiteWise outputs were split into “direct” and “indirect” energy use and greenhouse gas emissions. For definitions of direct and indirect energy use and emissions, please refer to section 2.2.2 of the evaluation report.

Cost calculations are based on cost information provided in Appendix A of the Draft FS. A summary cost sheet developed by the GSR Team is attached to this Appendix. Information regarding the cost calculations is as follows:

- The capital cost is $1,023,188 and occurs in year 0.

- The annual O&M cost is $0.

- The periodic cost is $3,105, occurring every five years in years 5, 10, 15, 20, 25, and 30.

- The sum of capital, annual, and periodic costs, non-discounted, is $1,041,818.

- To determine net present value (NPV), a 2.3 percent discount rate is applied to future costs, which is consistent with the discount rate applied in the Draft FS. NPV is calculated by discounting future costs to present-day dollars using the following equation:

$$PV = \frac{FV}{(1+i)^n} = C \times FV$$

PV is the present value
FV is the value in year “n” (i.e., future value)
i is the discount rate
C is the discount factor, which equals $1/(1+i)^n$

- The NPV calculated by the GSR Team is $1,035,939.

MEC Alternative 3 at INDA – Removal Action Fieldwork

<u>*Scope of Work*</u>

Appendix A of the Draft FS indicates 42.5 days of intrusive investigation (analog mag, flag, and dig), assuming approximately 200 anomalies per acre, and a production rate of 160 digs per day, which equates to 1.25 days per acre to conduct mag, flag, and dig. Appendix A also appears to (indirectly) indicate 10 hour days, based on labor hours per acre provided in Table A-5-3. The Draft FS assumes one BIP/consolidated shot per 1000 digs and demilitarization of 40 MD items per acre.

It is assumed that intrusive investigations for the various MRSs at IAAAP will be conducted separately (because of their long duration relative to the fencing/signage installation in Alternative 2), and therefore mob/demob footprints are not shared among the MEC Alternative 3 MRSs.

The Draft FS indicates that potential MEC items would be removed to a depth of 2 feet bgs using manual removal techniques (e.g., shovels, hand equipment), no use of heavy machinery is specified. Weights and quantities of materials are not further specified, and are assumed to be minimal (as is shipping of equipment). The GSR Team makes the assumptions indicated below in the SiteWise inputs section.

The following personnel will travel to the site for fieldwork:

- Two 7-person UXO dig teams for 42.5 days
- SUXOS and UXOQCS/SO for removal activities, MEC disposal evolutions, and MPPEH inspections
- Assume that Project Manager to provide project oversight and GIS specialist to maintain GIS anomaly tracking database will not be travelling to the site as a part of field activities (consistent with 16 field personnel noted in the "Per Diem" listing on Table A-5-3). No footprint is calculated for these two personnel.

Based on information provided by the Project Team on the Step 5 call which took place on 11/21/11, the 16 UXO technicians will be travelling alone (i.e., no carpooling) and will travel 8 hours one-way to the site via a combination of air and car. The GSR Team assumes that this will equate to approximately 100 miles via car and 700 miles via plane.

It is further assumed that UXO personnel will be staying in a nearby hotel in Burlington, IA for the extent of field work (43 round trips from the hotel to the site and back for each person). The equipment listed in Table A-5-3 includes 6 pick-up trucks per day for the duration of the remedial action (42.5 days), presumably for the UXO personnel. It is assumed that these will be used both for personnel transport from the hotel to the site and back and for on-site transport. Assuming that a round trip from the hotel to the site is ~12 miles, and an additional 3 miles per day of on-site transport, the GSR Team assumes a total of 15 miles per truck per day. It is also assumed that workers will carpool 2 or 3 people per vehicle (16 UXO personnel / 6 trucks = average of 2.67 passengers per trip).

Unlike the DGM subsurface clearance, Appendix A indicates that no additional field technicians will be needed for the analog subsurface clearance.

MEC Alternative 3 at INDA – Removal Action Fieldwork

<u>Input into "Remedial Action Construction" tab of SiteWise Input Sheet.xls</u>

- Baseline Information
  - Remedial Action Construction Cost
    - Total remedial action construction cost ($) – leave blank in SiteWise

- Material Production
  - Well Materials
  - Treatment Chemicals & Materials
  - Treatment Media
  - Construction Materials
  - Well Decommissioning
  - Bulk Material Quantities

- Transportation
  - Personnel Transportation – Road
    - Trip 1 – UXO Techs, car travel to and from site. Assume a car, gasoline. 100 miles one-way * 2 = 200 miles round trip, 16 trip (since there are 16 UXO personnel travelling separately), 1 traveler per car.
    - Trip 2 – UXO Techs, daily travel from hotel to site and on-site. Assume light trucks, gasoline. 12 miles round trip + 3 miles on-site = 15 miles per day, 43 trips (for each day of field work at site, rounded up to the nearest whole day) * 6 trucks = 258 trips, 2.67 travelers per truck (16 UXO techs / 6 trucks).
  - Personnel Transportation – Air
    - Trip 1 – UXO Tech, plane travel to and from site. 700 miles one-way * 2 = 1400 miles round trip, 16 traveler, 1 flight each.
  - Personnel Transportation – Rail
  - Equipment Transportation – Road
  - Equipment Transportation – Air
  - Equipment Transportation – Rail
  - Equipment Transportation – Water

- Equipment Use
  - Earthwork
  - Drilling
  - Trenching
  - Pump Operation
  - Diesel and Gasoline Pumps
  - Blower, Compressor, Mixer, and Other Equipment
  - Generators
  - Agricultural Equipment
  - Capping Equipment
  - Mixing Equipment
  - Internal Combustion Engines
  - Other Fueled Equipment
  - Operator Labor
  - Laboratory Analysis
  - Other Known Onsite Activities

- Residual Handling
    - Residue Disposal/Recycling
    - Landfill Operations
    - Thermal/Catalytic Oxidizers

- Resource Consumption
    - Water Consumption
    - Onsite Land and Water Resource Consumption

Once SiteWise input is complete, go to "SiteWise_Input Sheet" for overall project and enter information (including Alternative File Name "MEC 3 INDA"). Then go to "Generate Alternative" tab and click button labeled "Click to generate alternative using previously entered alternative name". Copies of the input and output summary sheets for this alternative are now located in the directory titled "RA_MEC 3 INDA_NoFR_1". To store the "Remedial Action Construction.xls" calculation sheet showing detailed calculations, open it in the overall SiteWise project directory when the appropriate input sheet is open, then do a "save as" to put it in the directory for this alternative using a name that indicates "will not update". Then open that file and do "data->edit links" and break the links. If the input sheet for this alternative ever changes, then this calculation sheet needs to be re-saved.

To edit input parameters for this alternative, you must go back to the ORIGINAL SiteWise input sheet and import this alternative using the "Do you want to reload a previously saved remedial alternative in the SiteWise input sheet?" field on the "Site Info" tab. After making necessary changes to the input sheet, re-export the alternative by going to the "Generate Alternative" tab and clicking the button labeled "Click to replace an existing alternative with the same name". Update saved calculation sheets as described above.

Other Supporting Calculations:
MEC Alternative 3 at the Incendiary Disposal Area MRS

% of Total Energy Usage from Renewable Resources

- None identified (since remedy construction will not require electricity use)

Hazardous Air Pollutants

- None identified

Refined Materials Use

- None identified. Specific mass of explosives for BIP has not been quantified, but is assumed to be a "refined material of undetermined but minor quantity".

Unrefined Materials Use

- None identified

Tons of Non-Hazardous Waste

- None identified

Tons of Hazardous Waste

- None identified

% of Potential Waste Recycled

- N/A

Risks to On-Site Workers and from Transportation

- Based on SiteWise output
    - On-Site worker injuries or fatalities = 0
    - Transportation related injuries or fatalities = 0.0086

Heavy Truck Trips through Residential Areas

- None identified

Project: GSR Pilot for IAAAP
Option or Alternative: MEC Alternative 3 at Incendiary Disposal Area
Current Date: 4/10/2012

year	up-front cost	annual cost	present value of cost each year	cumulative cash flow	
		(no discounting)	2.3%	no discounting	2.3%
0	$1,023,188	$0	$1,023,188	$1,023,188	$1,023,188
1	$0	$0	$0	$1,023,188	$1,023,188
2	$0	$0	$0	$1,023,188	$1,023,188
3	$0	$0	$0	$1,023,188	$1,023,188
4	$0	$0	$0	$1,023,188	$1,023,188
5	$0	$3,105	$2,771	$1,026,293	$1,025,959
6	$0	$0	$0	$1,026,293	$1,025,959
7	$0	$0	$0	$1,026,293	$1,025,959
8	$0	$0	$0	$1,026,293	$1,025,959
9	$0	$0	$0	$1,026,293	$1,025,959
10	$0	$3,105	$2,473	$1,029,398	$1,028,433
11	$0	$0	$0	$1,029,398	$1,028,433
12	$0	$0	$0	$1,029,398	$1,028,433
13	$0	$0	$0	$1,029,398	$1,028,433
14	$0	$0	$0	$1,029,398	$1,028,433
15	$0	$3,105	$2,208	$1,032,503	$1,030,640
16	$0	$0	$0	$1,032,503	$1,030,640
17	$0	$0	$0	$1,032,503	$1,030,640
18	$0	$0	$0	$1,032,503	$1,030,640
19	$0	$0	$0	$1,032,503	$1,030,640
20	$0	$3,105	$1,970	$1,035,608	$1,032,611
21	$0	$0	$0	$1,035,608	$1,032,611
22	$0	$0	$0	$1,035,608	$1,032,611
23	$0	$0	$0	$1,035,608	$1,032,611
24	$0	$0	$0	$1,035,608	$1,032,611
25	$0	$3,105	$1,759	$1,038,713	$1,034,369
26	$0	$0	$0	$1,038,713	$1,034,369
27	$0	$0	$0	$1,038,713	$1,034,369
28	$0	$0	$0	$1,038,713	$1,034,369
29	$0	$0	$0	$1,038,713	$1,034,369
30	$0	$3,105	$1,570	$1,041,818	$1,035,939

*positive dollar value is a "cost", negative dollar value is a "savings"

Net Present Value (NPV)-> $1,035,939

Total of capital costs (undiscounted) -> $1,023,188
Total of annual costs (undiscounted) -> $18,630

GSR Team Calculations to Split Energy Results from SiteWise into "Direct" and "Indirect"
MEC Alternative 3 at the INDA MRS

phase	Reported by SiteWise: activity	Reported by SiteWise: energy used (MMBTU)	Assigned by GSR Team from SiteWise Output: Scope 1 (direct) energy used (MMBTU)	Scope 2 (indirect) energy used (MMBTU)	Scope 3 (indirect) energy used (MMBTU)	Total Calculated by GSR Team
Removal Action Fieldwork ("Remedial Action Construction" tab)	Consumables	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	105.92	0.00	0.00	105.92	105.92
	Transportation-Equipment	0.00	0.00	0.00	0.00	0.00
	Equipment Use and Misc	0.00	0.00	0.00	0.00	0.00
	Residual Handling	0.00	0.00	0.00	0.00	0.00
	Sub-Total	105.92	0.00	0.00	105.92	105.92
total		105.92	0.00	0.00	105.92	105.92

Note: *Electricity use reported by SiteWise Version 2.0 in units of kWh is "Direct Scope 1", meaning it is energy consumed at the location of the project. However, energy use associated with electricity reported by SiteWise in units of MMBtu is a life-cycle value which also includes a factor to account for energy used elsewhere required to generate the electricity ("Indirect Scope 2"). Here, 33% of the life-cycle value reported by SiteWise is considered to be "Scope 1" on-site energy use, and 67% is considered to be "Scope 2" energy used in electricity generation.*

SiteWise Version 2.0 uses fuel energy values from U.S. Department of Energy, Argonne National Laboratory, Transportation Technology R&D Center, GREET 1.8d.1, Fuel-Cycle model, 2010. This version of the GREET model reports that for Gasoline and Diesel, approximately 19% of GHG emissions are upstream emissions (scope 3) and 81% are tailpipe emissions (scope 1). For this analysis, it is assumed that energy is used in these same proportions, and therefore the energy use reported by SiteWise is split between scope 3 and scope 1 in these ratios.

GSR Team Calculations to Split GHG Results from SiteWise into "Direct" and "Indirect"
MEC Alternative 3 at the INDA MRS

phase	Reported by SiteWise		Assigned by GSR Team from SiteWise Output			Total Calculated by GSR Team
			Scope 1 (direct)	Scope 2 (indirect)	Scope 3 (indirect)	
	activity	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	
Removal Action Fieldwork ("Remedial Action Construction" tab)	Consumables	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	8.12	0.00	0.00	8.12	8.12
	Transportation-Equipment	0.00	0.00	0.00	0.00	0.00
	Equipment Use and Misc	0.00	0.00	0.00	0.00	0.00
	Residual Handling	0.00	0.00	0.00	0.00	0.00
	Sub-Total	8.12	0.00	0.00	8.12	8.12
Total		8.12	0.00	0.00	8.12	8.12

Note: CO2e reported by SiteWise Version 2.0 for electricity use is all associated with generation of the electricity ("Indirect Scope 2").

SiteWise Version 2.0 use fuel emission factors from U.S. Department of Energy, Argonne National Laboratory, Transportation Technology R&D Center, GREET 1.8d.1, Fuel-Cycle model, 2010. This version of the GREET model reports that for gasoline and diesel, approximately 19% of GHG emissions are upstream emissions (Scope 3) and 81% are tailpipe emissions (Scope 1). For this analysis, the GHG emissions reported by SiteWise are split between Scope 3 and Scope 1 in these ratios.

APPENDIX C

Assumptions for SiteWise Input and Other Calculations, Iowa Army Ammunition Plant (MC Alternatives):

APPENDIX C-1:

MC Alternative 2 at the Possible Demolition Site MRS

Appendix C-1
Assumptions for SiteWise Input and Other Calculations
Iowa Army Ammunition Plant GSR Evaluation:
MC Alternative 2 at the Possible Demolition Site MRS

SiteWise "RA_MC 2 PDS_NoFR_1" Directory

Appendix C-1 of this report includes notes for the footprinting of MC Alternative 2 at the PDS MRS. For the purposes of footprinting, this alternative will involve the following components:

- Construction of two groundwater monitoring wells and MC lab sample analysis, including one UXO Tech II for anomaly avoidance during intrusive construction activities and one geologist for oversight of drilling activities
- Replacement of each well once over 30 years
- Annual groundwater sampling performed by one geologist and one UXO Tech II

Unless otherwise noted, SiteWise inputs are based on the information described in Appendix A and the report text of the *Draft Feasibility Study (FS) Report* (dated November 2011). When information required for SiteWise input was not provided, reasonable assumptions were made (these assumptions are noted in the description of SiteWise input below).

The notes pertaining to SiteWise input are organized by the following tabs of the SiteWise input sheet:

- Installation of Engineering Controls – Uses *"Remedial Action Construction"* tab of SiteWise input sheet
- Annual O&M – Uses *"Remedial Action Operations"* tab of SiteWise input sheet

For each section of SiteWise, all the sections are listed, with pertinent information added only for those sections of the input sheet where data were added.

In some cases, small quantities of materials were not included in SiteWise input because the footprint of these items relative to the other materials used would be expected to be extremely minimal.

Other calculations done outside of SiteWise are then presented. These include the following:

- % of total energy from renewable resources
- Hazardous air pollutants
- Refined material use
- Unrefined material use
- Tons of non-hazardous waste
- Tons of hazardous waste
- % of Potential Waste Recycled
- Risks to on-site works and from transportation
- Heavy truck trips through residential areas

MC Alternative 2 at PDS – Overview

Additional tables are attached which show how SiteWise outputs were split into “direct” and “indirect” energy use and greenhouse gas emissions. For definitions of direct and indirect energy use and emissions, please refer to section 2.2.2 of the evaluation report.

Cost calculations are based on cost information provided in Appendix B of the Draft FS. A summary cost sheet developed by the GSR Team is attached to this Appendix. Information regarding the cost calculations is as follows:

- The capital cost is $175,501 and occurs in year 0.

- The annual O&M cost is $6,155, occurring each year in years 1 through 30.

- The periodic cost is $6,210, occurring every five years in years 5, 10, 15, 20, 25, and 30.

- The sum of capital, annual, and periodic costs, non-discounted, is $397,411.

- To determine net present value (NPV), a 2.3 percent discount rate is applied to future costs, which is consistent with the discount rate applied in the Draft FS. NPV is calculated by discounting future costs to present-day dollars using the following equation:

$$PV = \frac{FV}{(1+i)^n} = C \times FV$$

  PV is the present value
  FV is the value in year “n” (i.e., future value)
  i is the discount rate
  C is the discount factor, which equals $1/(1+i)^n$

- The NPV calculated by the GSR Team is $333,332.

MC Alternative 2 at PDS – Installation of Engineering Controls

<u>Scope of Work</u>

Appendix B of the Draft FS indicates that engineering controls will include installation and development of two LTM wells. The necessary materials (combined for both wells) include 60 ft of 2" PVC (Schedule 40), 20 ft of 2" PVC slotted screen (Schedule 40), filter pack sand for 24 ft of well length, annular seal for 56 ft of well length, a bentonite seal and flush mount completions for each well (assumed to be a minimal amount of material), and 80 ft of polyethylene tubing. Table B-5 of the Draft FS says that 4-1/4 inch inner diameter hollow stem augers will be used for drilling, and for the purpose of estimating annular space, the GSR Team assumes that this will result in a borehole that is approximately 8" in diameter.

Appendix B of the Draft FS indicates that one UXO Tech II will be needed for anomaly avoidance during intrusive construction activities. Based on information provided by the Project Team on the Step 5 call which took place on 11/21/11, UXO technicians will be travelling alone (i.e., no carpooling) and will travel 8 hours one-way to the site via a combination of air and car. The GSR Team assumes that this will equate to approximately 100 miles via car and 700 miles via plane. It is further assumed that the UXO Tech will be staying in a nearby hotel in Burlington, IA (~12 miles round trip to site and back) for two nights (since Draft FS Table B-5 indicates two days of drilling).

Since Table B-5 also includes airfare and 16 hours roundtrip for the geologist, it is assumed that this person will be traveling a distance similar to that traveled by the UXO Tech and staying in the same hotel (or one nearby). Table B-5 indicates that the geologist will be needed for a total of 5 days (including one day for field preparation and two days for well development). This table also indicates that a truck will be rented for 4 days, but the GSR team assumes that a vehicle will be needed for 5 days total to transport the geologist and the UXO Tech from the hotel to the site and back (assuming they will carpool for the days that the UXO Tech is needed).

The Project Team stated on the Step 5 call that the driller would be travelling from within 50 miles of the site. The GSR Team assumes two drillers, one drill rig (which will remain on-site for extent of drilling), and one light truck for travel back and forth to the site. Assume that drillers will be on-site for 4 days (2 days of well drilling and 2 days of well development).

Samples will also be collected as a part of engineering control installation and sent off-site for lab analysis. The Project Team stated on the Step 5 call that samples for explosives and metals are sent to a lab in Torrance, CA, which is approximately 1600 miles from the site, one-way, by air (the GSR Team assumes air shipping due to the distance that samples will need to be shipped). Table B-3 of the Draft FS lists four each of "MC Laboratory Sample Analysis". The GSR Team assumes this is equal to four coolers containing samples.

MC Alternative 2 at PDS – Installation of Engineering Controls

Input into "Remedial Action Construction" tab of SiteWise Input Sheet.xls

- Baseline Information
  - Remedial Action Construction Cost
    - Total remedial action construction cost ($) – leave blank in SiteWise

- Material Production
  - Well Materials
    - Well Type 1 – Well casing and screens. 2 wells, 40 ft each (80 ft / 2 wells, assuming both wells are of equal depth). Select Schedule 40 PVC, 2" diameter.
  - Treatment Chemicals & Materials
  - Treatment Media
  - Construction Materials
  - Well Decommissioning
  - Bulk Material Quantities
    - Material 1 – Annular seal for both wells. Select "Typical cement" to represent annular seal material. Select "cubic feet". To calculate volume of cement needed, determine total volume within borehole (π * (4 inch borehole radius / 12 inches per foot)^2 * length to be filled) and subtract volume within well casing (π * (1 inch well casing radius / 12 inches per foot)^2 * length to be filled) for the interval where cement will be present. For the two wells, total interval height is 56 feet. Total volume of cement calculated is 19.55 cubic feet – 1.22 cubic feet = 18.33 cubic feet.
    - Material 2 – Filter pack sand for both wells. Select "Sand" and "cubic feet". To calculate volume of cement needed, determine total volume within borehole (π * (4 inch borehole radius / 12 inches per foot)^2 * length to be filled) and subtract volume within well casing (π * (1 inch well casing radius / 12 inches per foot)^2 * length to be filled) for the interval where filter pack will be present. For the two wells, total filter pack height is 24 feet. Total volume of sand calculated is 8.38 cubic feet – 0.52 cubic feet = 7.86 cubic feet.
    - Material 3 – Polyethylene tubing. Select "LDPE" to represent tubing. Select "pounds". Assume 0.015 lbs per foot * 80 feet = 1.2 pounds total.

- Transportation
  - Personnel Transportation – Road
    - Trip 1 – UXO Tech and geologist car travel to and from site. Assume a car, gasoline. 100 miles one-way * 2 = 200 miles round trip, 2 trips (one per person), 1 traveler per car (since they will not be carpooling).
    - Trip 2 – UXO Tech and geologist carpooling from hotel to site. Assume a light truck, gasoline. 12 miles round trip, 2 trips (for 2 days of drilling at site), 2 travelers.
    - Trip 3 – Geologist traveling alone from hotel to site. Assume a light truck, gasoline. 12 miles round trip, 3 trips (for one day of field preparation and two days of well development), 1 traveler.
    - Trip 4 – Drill rig travel one-time to and from site. Assume "heavy duty" truck, diesel. 50 miles one-way * 2 = 100 miles round trip, 1 trip (assuming rig left on-site for duration of drilling), 1 traveler.

        - Trip 5 – Truck for drillers' daily travel to and from site. Assume a light truck, gasoline. 50 miles one-way * 2 = 100 miles round trip, 4 trips (for 2 days of drilling plus 2 days of well development), 1.75 travelers average (assuming one round trip with one passenger only while other driller drives rig, and 3 round trips where both drillers carpool).
    - Personnel Transportation – Air
        - Trip 1 – UXO Tech and geologist, plane travel to and from site. 700 miles one-way * 2 = 1400 miles round trip, 2 travelers, 1 flight per person.
    - Personnel Transportation – Rail
    - Equipment Transportation – Road
        - Trip 1 – Transport of all well materials to site. Assuming these materials will be brought to site in light truck with driller, select gasoline and 50 miles one way. Estimated total weight (from SiteWise output sheet) = 26.1 kg (well casing) + 781.7 kg (cement) + 411.8 kg (sand) + 0.5 kg (polyethylene tubing) = 1220.1 kg / 907.18 kg per ton = 1.34 tons. Since fuel use for contractor return trips is already accounted for in Personnel Transportation above, no empty return trips are included here.
    - Equipment Transportation – Air
        - Trip 1 – Empty coolers and bottles sent from lab to site for MC sampling. Assume 1600 miles, 10 lbs per cooler * 4 coolers / 2000 lbs per ton = 0.02 tons.
        - Trip 2 – Full coolers with samples sent from site to lab. Assume 1600 miles, 50 lbs per cooler * 4 coolers / 2000 lbs per ton = 0.1 tons.
    - Equipment Transportation – Rail
    - Equipment Transportation – Water

- Equipment Use
    - Earthwork
    - Drilling
        - Event 1 – Drilling both LTM wells. 2 wells, select Hollow Stem Auger, assume 8 hours of drilling at each location (assuming ~2 hours down time during a 10 hour work day). Select diesel.
    - Trenching
    - Pump Operation
    - Diesel and Gasoline Pumps
    - Blower, Compressor, Mixer, and Other Equipment
    - Generators
    - Agricultural Equipment
    - Capping Equipment
    - Mixing Equipment
    - Internal Combustion Engines
    - Other Fueled Equipment
    - Operator Labor
    - Laboratory Analysis
    - Other Known Onsite Activities

- Residual Handling
    - Residue Disposal/Recycling
    - Landfill Operations

  - Thermal/Catalytic Oxidizers

- Resource Consumption
  - Water Consumption
  - Onsite Land and Water Resource Consumption

Once SiteWise input is complete, go to "SiteWise_Input Sheet" for overall project and enter information (including Alternative File Name "MC 2 PDS"). Then go to "Generate Alternative" tab and click button labeled "Click to generate alternative using previously entered alternative name". Copies of the input and output summary sheets for this alternative are now located in the directory titled "RA_MC 2 PDS_NoFR_1". To store the "Remedial Action Construction.xls" calculation sheet showing detailed calculations, open it in the overall SiteWise project directory when the appropriate input sheet is open, then do a "save as" to put it in the directory for this alternative using a name that indicates "will not update". Then open that file and do "data->edit links" and break the links. If the input sheet for this alternative ever changes, then this calculation sheet needs to be re-saved.

To edit input parameters for this alternative, you must go back to the ORIGINAL SiteWise input sheet and import this alternative using the "Do you want to reload a previously saved remedial alternative in the SiteWise input sheet?" field on the "Site Info" tab. After making necessary changes to the input sheet, re-export the alternative by going to the "Generate Alternative" tab and clicking the button labeled "Click to replace an existing alternative with the same name". Update saved calculation sheets as described above.

MC Alternative 2 at PDS – Annual O&M

<u>*Scope of Work*</u>

Appendix B of the Draft FS indicates that both wells will be replaced once in the course of the 30 year remedy timeframe. Due to the similar cost listed for well replacement (which is shown as an annual cost divided out over 30 years), it is assumed that the footprint for well replacement will involve the same components as well installation (unless otherwise noted). In addition to installation of the new replacement wells, it is assumed that the original wells will be decommissioned.

The necessary materials (combined for both replacement wells) include 60 ft of 2" PVC (Schedule 40), 20 ft of 2" PVC slotted screen (Schedule 40), filter pack sand for 24 ft of well length, annular seal for 56 ft of well length, a bentonite seal and flush mount completions for each well (assumed to be a minimal amount of material), and 80 ft of polyethylene tubing. Table B-5 of the Draft FS says that 4-1/4 inch inner diameter hollow stem augers will be used for drilling, and for the purpose of estimating annular space, the GSR Team assumes that this will result in a borehole that is approximately 8" in diameter.

Appendix B of the Draft FS indicates that one UXO Tech II will be needed for anomaly avoidance during intrusive construction activities. Based on information provided by the Project Team on the Step 5 call which took place on 11/21/11, UXO technicians will be travelling alone (i.e., no carpooling) and will travel 8 hours one-way to the site via a combination of air and car. The GSR Team assumes that this will equate to approximately 100 miles via car and 700 miles via plane. It is further assumed that the UXO Tech will be staying in a nearby hotel in Burlington, IA (~12 miles round trip to site and back) for two nights (since Draft FS Table B-5 indicates two days of drilling).

Since Table B-5 also includes airfare and 16 hours roundtrip for the geologist, it is assumed that this person will be traveling a distance similar to that traveled by the UXO Tech and staying in the same hotel (or one nearby). Table B-5 indicates that the geologist will be needed for a total of 5 days (one for field preparation and two for well development). This table also indicates that a truck will be rented for 4 days, but the GSR team assumes that a vehicle will be needed for 5 days total to transport the geologist and the UXO Tech from the hotel to the site and back (assuming they will carpool for the days that the UXO Tech is needed).

The Project Team stated on the Step 5 call that the driller would be travelling from within 50 miles of the site. The GSR Team assumes two drillers, one drill rig (which will remain on-site for extent of drilling), and one light truck for travel back and forth to the site. Assume that drillers will be on-site for 4 days (2 days of well drilling and 2 days of well development).

Annual groundwater sampling will require one geologist and one UXO Tech to travel to the site (assume the required yearly travel will be similar to travel listed above, with only one round trip from the hotel for the single day of field work required). The Project Team stated on the Step 5 call that samples for explosives and metals are sent to a lab in Torrence, CA, which is approximately 1600 miles from the site, one-way, by air (the GSR Team assumes air shipping due to the distance that samples will need to be shipped). The GSR Team assumes that four coolers worth of samples will be sent off-site for lab analysis once a year for 30 years.

MC Alternative 2 at PDS – Annual O&M

<u>Input into "Remedial Action Operations" tab of SiteWise Input Sheet.xls</u>

- Baseline Information
  - Remedial Action Operations Cost and Duration
    - Total remedial action operations cost ($) – leave blank in SiteWise
    - Duration of remedial action operations (unit time) – 1 yr for this GSR evaluation because we have multiplied input items by number of years as part of the input

- Material Production
  - Well Materials
    - Well Type 1 – Replacement well casing and screens. 2 wells, 40 ft each (80 ft / 2 wells, assuming both wells are of equal depth). Select Schedule 40 PVC, 2" diameter.
  - Treatment Chemicals & Materials
  - Treatment Media
  - Construction Materials
  - Well Decommissioning
    - Well Type 1 – Decommissioning of original LTM wells. 2 wells, 40 ft each, 2" diameter. Select "Typical cement" (assumed).
  - Bulk Material Quantities
    - Material 1 – Annular seal for both wells. Select "Typical cement" to represent annular seal material. Select "cubic feet". To calculate volume of cement needed, determine total volume within borehole (π * (4 inch borehole radius / 12 inches per foot)^2 * length to be filled) and subtract volume within well casing (π * (1 inch well casing radius / 12 inches per foot)^2 * length to be filled) for the interval where cement will be present. For the two wells, total interval height is 56 feet. Total volume of cement calculated is 19.55 cubic feet – 1.22 cubic feet = 18.33 cubic feet.
    - Material 2 – Filter pack sand for both wells. Select "Sand" and "cubic feet". To calculate volume of cement needed, determine total volume within borehole (π * (4 inch borehole radius / 12 inches per foot)^2 * length to be filled) and subtract volume within well casing (π * (1 inch well casing radius / 12 inches per foot)^2 * length to be filled) for the interval where filter pack will be present. For the two wells, total filter pack height is 24 feet. Total volume of sand calculated is 8.38 cubic feet – 0.52 cubic feet = 7.86 cubic feet.
    - Material 3 – Polyethylene tubing. Select "LDPE" to represent tubing. Select "pounds". Assume 0.015 lbs per foot * 80 feet = 1.2 pounds total.

- Transportation
  - Personnel Transportation – Road
    - Trip 1 – UXO Tech and geologist car travel to and from site for well replacement plus annual sampling. Assume a car, gasoline. 100 miles one-way * 2 = 200 miles round trip, 2 trips (one per person) * 31 site visits over 30 years (annual sampling + 1-time well replacement) = 62 trips total, 1 traveler per car (since they will not be carpooling).
    - Trip 2 – UXO Tech and geologist carpooling from hotel to site for well replacement plus annual sampling. Assume a light truck, gasoline. 12 miles

round trip, 2 trips (for 2 days of drilling at site) plus 1 trip per year for 30 years of annual sampling = 32 trips, 2 traveler.
    - Trip 3 – Geologist traveling alone from hotel to site for well replacement. Assume a light truck, gasoline. 12 miles round trip, 3 trips (for one day of field preparation and two days of well development), 1 traveler.
    - Trip 4 – Drill rig travel one-time to and from site for well replacement. Assume "heavy duty" truck, diesel. 50 miles one-way * 2 = 100 miles round trip, 1 trip (assuming rig left on-site for duration of drilling), 1 traveler.
    - Trip 5 – Truck for drillers' daily travel to and from site. Assume a light truck, gasoline. 50 miles one-way * 2 = 100 miles round trip, 4 trips (for 2 days of drilling plus 2 days of well development), 1.75 travelers average (assuming one round trip with one passenger only while other driller drives rig, and 3 round trips where both drillers carpool).
  - Personnel Transportation – Air
    - Trip 1 – UXO Tech and geologist, plane travel to and from site for well replacement plus annual sampling. 700 miles one-way * 2 = 1400 miles round trip, 2 travelers, 1 flight per person for well installation plus 30 flights per person for annual sampling = 31 flights per person.
  - Personnel Transportation – Rail
  - Equipment Transportation – Road
    - Trip 1 – Transport of all well materials to site. Assuming these materials will be brought to site in light truck with driller, select gasoline and 50 miles one way. Estimated total weight (from SiteWise output sheet) = 26.1 kg (well casing) + 74.4 kg (cement for well decommissioning) + 781.7 kg (cement for annular seal) + 411.8 kg (sand) + 0.5 kg (polyethylene tubing) = 1294.5 kg / 907.18 kg per ton = 1.43 tons. Since fuel use for contractor return trips is already accounted for in Personnel Transportation above, no empty return trips are included here.
  - Equipment Transportation – Air
    - Trip 1 – Empty coolers and bottles sent from lab to site for MC sampling. Assume 1600 miles, 10 lbs per cooler * 4 coolers * 30 sampling events / 2000 lbs per ton = 0.6 tons.
    - Trip 2 – Full coolers with samples sent from site to lab. Assume 1600 miles, 50 lbs per cooler * 4 coolers * 30 sampling events / 2000 lbs per ton = 3 tons.
  - Equipment Transportation – Rail
  - Equipment Transportation – Water

- Equipment Use
  - Earthwork
  - Drilling
    - Event 1 – Drilling both replacement wells. 2 wells, select Hollow Stem Auger, assume 8 hours of drilling at each location (assuming ~2 hours down time during a 10 hour work day). Select diesel.
  - Trenching
  - Pump Operation
  - Diesel and Gasoline Pumps
  - Blower, Compressor, Mixer, and Other Equipment
  - Generators
  - Agricultural Equipment

- Capping Equipment
- Mixing Equipment
- Internal Combustion Engines
- Other Fueled Equipment
- Operator Labor
- Laboratory Analysis
- Other Known Onsite Activities

- Residual Handling
  - Residue Disposal/Recycling
  - Landfill Operations
  - Thermal/Catalytic Oxidizers

- Resource Consumption
  - Water Consumption
  - Onsite Land and Water Resource Consumption

Once SiteWise input is complete, go to "SiteWise_Input Sheet" for overall project and enter information (including Alternative File Name "MC 2 PDS"). Then go to "Generate Alternative" tab and click button labeled "Click to generate alternative using previously entered alternative name". Copies of the input and output summary sheets for this alternative are now located in the directory titled "RA_MC 2 PDS_NoFR_1". To store the "Remedial Action Operations.xls" calculation sheet showing detailed calculations, open it in the overall SiteWise project directory when the appropriate input sheet is open, then do a "save as" to put it in the directory for this alternative using a name that indicates "will not update". Then open that file and do "data->edit links" and break the links. If the input sheet for this alternative ever changes, then this calculation sheet needs to be re-saved.

To edit input parameters for this alternative, you must go back to the ORIGINAL SiteWise input sheet and import this alternative using the "Do you want to reload a previously saved remedial alternative in the SiteWise input sheet?" field on the "Site Info" tab. After making necessary changes to the input sheet, re-export the alternative by going to the "Generate Alternative" tab and clicking the button labeled "Click to replace an existing alternative with the same name". Update saved calculation sheets as described above.

Other Supporting Calculations:
MC Alternative 2 at the Possible Demolition Site MRS

% of Total Energy Usage from Renewable Resources

- None identified

Hazardous Air Pollutants

- None identified

Refined Materials Use

- From SiteWise output sheet for "Remedial Action Construction", which is for drilling two wells, the total is 808 kg = 1778 lbs consisting of:
  - 26.1 kg (PVC for well casing/screen)
  - 781.7 kg (cement/grout)
  - 0.5 kg (polyethylene tubing)
- From SiteWise output sheet for "Remedial Action Operation", which is for decommissioning those two wells and drilling two replacement wells, the total is 883 kg = 1943 lbs consisting of:
  - 26.1 kg (PVC for well casing/screen)
  - 781.7 kg (cement/grout)
  - 0.5 kg (polyethylene tubing)
  - 74.4 kg (cement for decommissioning wells)

Unrefined Materials Use

- From SiteWise output sheet for "Remedial Action Construction", which is for drilling two wells, the total is 411.8 kg = 0.45 tons consisting of:
  - 411.8 kg (sand for filter pack)
- From SiteWise output sheet for "Remedial Action Operation", which is for decommissioning those two wells and drilling two replacement wells the total is 411.8 kg = 0.45 tons consisting of:
  - 411.8 kg (sand for filter pack

Tons of Non-Hazardous Waste

- None identified

MC Alternative 2 at PDS – Other Supporting Calculations

Tons of Hazardous Waste

- None identified

% of Potential Waste Recycled

- N/A

Risks to On-Site Workers and from Transportation

- Based on SiteWise output
  - On-Site worker injuries or fatalities = 0.007
  - Transportation related injuries or fatalities = 0.0098

Heavy Truck Trips through Residential Areas

- None identified

Project: GSR Pilot for IAAAP
Option or Alternative: MC Alternative 2 at Possible Demolition Site
Current Date: 4/10/2012

year	up-front cost	annual cost	present value of cost each year	cumulative cash flow	
		(no discounting)	2.3%	no discounting	2.3%
0	$175,501	$0	$175,501	$175,501	$175,501
1	$0	$6,155	$6,017	$181,656	$181,518
2	$0	$6,155	$5,881	$187,811	$187,399
3	$0	$6,155	$5,749	$193,966	$193,148
4	$0	$6,155	$5,620	$200,121	$198,768
5	$0	$12,365	$11,036	$212,486	$209,804
6	$0	$6,155	$5,370	$218,641	$215,174
7	$0	$6,155	$5,249	$224,796	$220,423
8	$0	$6,155	$5,131	$230,951	$225,555
9	$0	$6,155	$5,016	$237,106	$230,570
10	$0	$12,365	$9,850	$249,471	$240,420
11	$0	$6,155	$4,793	$255,626	$245,213
12	$0	$6,155	$4,685	$261,781	$249,898
13	$0	$6,155	$4,580	$267,936	$254,478
14	$0	$6,155	$4,477	$274,091	$258,955
15	$0	$12,365	$8,791	$286,456	$267,747
16	$0	$6,155	$4,278	$292,611	$272,024
17	$0	$6,155	$4,182	$298,766	$276,206
18	$0	$6,155	$4,088	$304,921	$280,293
19	$0	$6,155	$3,996	$311,076	$284,289
20	$0	$12,365	$7,847	$323,441	$292,136
21	$0	$6,155	$3,818	$329,596	$295,954
22	$0	$6,155	$3,732	$335,751	$299,686
23	$0	$6,155	$3,648	$341,906	$303,334
24	$0	$6,155	$3,566	$348,061	$306,901
25	$0	$12,365	$7,003	$360,426	$313,904
26	$0	$6,155	$3,408	$366,581	$317,312
27	$0	$6,155	$3,331	$372,736	$320,643
28	$0	$6,155	$3,256	$378,891	$323,899
29	$0	$6,155	$3,183	$385,046	$327,082
30	$0	$12,365	$6,251	$397,411	$333,332

*positive dollar value is a "cost", negative dollar value is a "savings"

Net Present Value (NPV)-> $333,332

Total of capital costs (undiscounted) -> $175,501
Total of annual costs (undiscounted) -> $221,910

GSR Team Calculations to Split Energy Results from SiteWise into "Direct" and "Indirect"
MC Alternative 2 at the PDS MRS

phase	Reported by SiteWise activity	energy used (MMBTU)	Assigned by GSR Team from SiteWise Output: Scope 1 (direct) energy used (MMBTU)	Scope 2 (indirect) energy used (MMBTU)	Scope 3 (indirect) energy used (MMBTU)	Total Calculated by GSR Team
Installation of Engineering Controls ("Remedial Action Construction" tab)	Consumables	5.16	0.00	0.00	5.16	5.16
	Transportation-Personnel	14.91	0.00	0.00	14.91	14.91
	Transportation-Equipment	2.80	0.00	0.00	2.80	2.80
	Equipment Use and Misc	16.41	13.29	0.00	3.12	16.41
	Residual Handling	0.00	0.00	0.00	0.00	0.00
	Sub-Total	39.29	13.29	0.00	25.99	39.29
Annual O&M ("Remedial Action Operations" tab)	Consumables	5.49	0.00	0.00	5.49	5.49
	Transportation-Personnel	313.75	0.00	0.00	313.75	313.75
	Transportation-Equipment	56.25	0.00	0.00	56.25	56.25
	Equipment Use and Misc	16.41	13.29	0.00	3.12	16.41
	Residual Handling	0.00	0.00	0.00	0.00	0.00
	Sub-Total	391.90	13.29	0.00	378.61	391.90
total		431.19	26.58	0.00	404.60	431.19

Note: Electricity use reported by SiteWise Version 2.0 in units of kWh is "Direct Scope 1", meaning it is energy consumed at the location of the project. However, energy use associated with electricity reported by SiteWise in units of MMBtu is a life-cycle value which also includes a factor to account for energy used elsewhere required to generate the electricity ("Indirect Scope 2"). Here, 33% of the life-cycle value reported by SiteWise is considered to be "Scope 1" on-site energy use, and 67% is considered to be "Scope 2" energy used in electricity generation.

SiteWise Version 2.0 uses fuel energy values from U.S. Department of Energy, Argonne National Laboratory, Transportation Technology R&D Center, GREET 1.8d.1, Fuel-Cycle model, 2010. This version of the GREET model reports that for Gasoline and Diesel, approximately 19% of GHG emissions are upstream emissions (scope 3) and 81% are tailpipe emissions (scope 1). For this analysis, it is assumed that energy is used in these same proportions, and therefore the energy use reported by SiteWise is split between scope 3 and scope 1 in these ratios.

GSR Team Calculations to Split GHG Results from SiteWise into "Direct" and "Indirect"
MC Alternative 2 at the PDS MRS

phase	Reported by SiteWise		Assigned by GSR Team from SiteWise Output			Total Calculated by GSR Team
			Scope 1 (direct)	Scope 2 (indirect)	Scope 3 (indirect)	
	activity	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	
Installation of Engineering Controls ("Remedial Action Construction" tab)	Consumables	0.73	0.00	0.00	0.73	0.73
	Transportation-Personnel	1.14	0.00	0.00	1.14	1.14
	Transportation-Equipment	0.33	0.00	0.00	0.33	0.33
	Equipment Use and Misc	1.36	1.10	0.00	0.26	1.36
	Residual Handling	0.00	0.00	0.00	0.00	0.00
	Sub-Total	3.57	1.10	0.00	2.47	3.57
Annual O&M (“Remedial Action Operations” tab)	Consumables	0.79	0.00	0.00	0.79	0.79
	Transportation-Personnel	23.79	0.00	0.00	23.79	23.79
	Transportation-Equipment	7.98	0.00	0.00	7.98	7.98
	Equipment Use and Misc	1.36	1.10	0.00	0.26	1.36
	Residual Handling	0.00	0.00	0.00	0.00	0.00
	Sub-Total	33.93	1.10	0.00	32.83	33.93
Total		37.50	2.20	0.00	35.30	37.50

Note: CO2e reported by SiteWise Version 2.0 for electricity use is all associated with generation of the electricity (“Indirect Scope 2”).

SiteWise Version 2.0 use fuel emission factors from U.S. Department of Energy, Argonne National Laboratory, Transportation Technology R&D Center, GREET 1.8d.1, Fuel-Cycle model, 2010. This version of the GREET model reports that for gasoline and diesel, approximately 19% of GHG emissions are upstream emissions (Scope 3) and 81% are tailpipe emissions (Scope 1). For this analysis, the GHG emissions reported by SiteWise are split between Scope 3 and Scope 1 in these ratios.

APPENDIX C-2:

MC Alternative 3 at the Possible Demolition Site MRS

Appendix C-2
Assumptions for SiteWise Input and Other Calculations
Iowa Army Ammunition Plant GSR Evaluation:
MC Alternative 3 at the Possible Demolition Site MRS

SiteWise "RA_MC 3 PDS_NoFR_1" Directory

Appendix C-2 of this report includes notes for the footprinting of MC Alternative 3 at the PDS MRS. For the purposes of footprinting, this alternative will involve the following components:

- Removal with off-site disposal of RDX contaminated soil
- Additional soil sampling to further define RDX subsurface soil contamination
- Excavation of 200 BCY of contaminated soil (300 tons), and transport/disposal in an off-site landfill
- Excavated area will be backfilled, re-graded, and restored to previous conditions
- Field personnel include two UXO Tech II, one geologist, and subcontractors for 5 days

Unless otherwise noted, SiteWise inputs are based on the information described in Appendix A and the report text of the *Draft Feasibility Study (FS) Report* (dated November 2011). When information required for SiteWise input was not provided, reasonable assumptions were made (these assumptions are noted in the description of SiteWise input below).

The notes pertaining to SiteWise input are organized by the following tabs of the SiteWise input sheet:

- Removal with Off-Site Disposal Fieldwork – Uses *"Remedial Action Construction"* tab of SiteWise input sheet

For each section of SiteWise, all the sections are listed, with pertinent information added only for those sections of the input sheet where data were added.

In some cases, small quantities of materials were not included in SiteWise input because the footprint of these items relative to the other materials used would be expected to be extremely minimal.

Other calculations done outside of SiteWise are then presented. These include the following:

- % of total energy from renewable resources
- Hazardous air pollutants
- Refined material use
- Unrefined material use
- Tons of non-hazardous waste
- Tons of hazardous waste
- % of Potential Waste Recycled
- Risks to on-site works and from transportation
- Heavy truck trips through residential areas

MC Alternative 3 at PDS – Overview

Additional tables are attached which show how SiteWise outputs were split into "direct" and "indirect" energy use and greenhouse gas emissions. For definitions of direct and indirect energy use and emissions, please refer to section 2.2.2 of the evaluation report.

Cost calculations are based on cost information provided in Appendix B of the Draft FS. A summary cost sheet developed by the GSR Team is attached to this Appendix. Information regarding the cost calculations is as follows:

- The capital cost is $231,029 and occurs in year 0.
- The annual O&M cost is $0.
- The periodic cost is $6,210, occurring every five years in years 5, 10, 15, 20, 25, and 30.
- The sum of capital, annual, and periodic costs, non-discounted, is $268,289.
- To determine net present value (NPV), a 2.3 percent discount rate is applied to future costs, which is consistent with the discount rate applied in the Draft FS. NPV is calculated by discounting future costs to present-day dollars using the following equation:

$$PV = \frac{FV}{(1+i)^n} = C \times FV$$

PV is the present value
FV is the value in year "n" (i.e., future value)
i is the discount rate
C is the discount factor, which equals $1/(1+i)^n$

- The NPV calculated by the GSR Team is $256,531.

MC Alternative 3 at PDS – Removal with Off-Site Disposal Fieldwork

Scope of Work

Appendix B of the Draft FS indicates that 200 cubic yards of soil will require excavation and transportation to a non-hazardous landfill, and the excavated area will be backfilled, compacted, graded, and re-seeded. It is assumed that an excavator will be used to remove soil and backfill/compact the excavated area, and the Project Team indicated on the Step 5 call that backfill will be obtained from an on-site borrow area within 500 ft of the excavated area. The Project Team also indicated that the 200 cubic yards (300 tons, based on 1.5 tons per cubic yard) of soil will be disposed of in a subtitle D landfill within 50 miles of the site.

Appendix B of the Draft FS indicates that field personnel will include two UXO Tech II and one geologist. Based on information provided by the Project Team on the Step 5 call which took place on 11/21/11, UXO technicians will be travelling alone (i.e., no carpooling) and will travel 8 hours one-way to the site via a combination of air and car. The GSR Team assumes that this will equate to approximately 100 miles via car and 700 miles via plane. It is further assumed that the UXO personnel will be staying in a nearby hotel in Burlington, IA (~12 miles round trip to site and back) for five nights (since Draft FS Table B-6 indicates five days of field work). Table B-6 lists 5 days of truck rental, and it is assumed that this truck will be used by the two UXO technicians for transport from the hotel to the site.

The Project Team indicated on the Step 5 call that the regular field technicians (presumably this includes the geologist, based on the cost listed for mob/demob of the 3-person crew) will likely be driving from 3 to 4 hours away. The GSR Team assumes that this will equate to approximately 200 miles one way via light truck. The GSR Team assumes that regular field technicians will also stay in a nearby hotel in Burlington, IA for the extent of field work (5 round trips from the hotel to the site and back).

Appendix B of the Draft FS also states that a subcontractor will be used for construction. The GSR Team assumes this will consist of two additional persons traveling from within 50 miles, and that the excavator will be transported to the site from approximately the same distance.

Samples will also be collected as a part of the planned fieldwork and sent off-site for lab analysis. The Project Team stated on the Step 5 call that samples for explosives and metals are sent to a lab in Torrence, CA, which is approximately 1600 miles from the site, one-way, by air (the GSR Team assumes air shipping due to the distance that samples will need to be shipped). Table B-3 of the Draft FS lists 22 each of “MC Laboratory Sample Analysis”. The GSR Team assumes this is equal to 22 coolers containing samples.

Table B-6 also lists seeding of the disturbed area, topographic surveys, and PPE/decon/miscellaneous supplies. It is assumed that the footprints for these items will be minimal, and they are therefore not included in SiteWise inputs. In addition, the GSR Team assumes that maintenance of the seeded area will occur as a part of regular site maintenance, and therefore no additional footprint for this item is quantified here.

MC Alternative 3 at PDS – Removal with Off-Site Disposal Fieldwork

Input into "Remedial Action Construction" tab of SiteWise Input Sheet.xls

- Baseline Information
    - Remedial Action Construction Cost
        - Total remedial action construction cost ($) – leave blank in SiteWise

- Material Production
    - Well Materials
    - Treatment Chemicals & Materials
    - Treatment Media
    - Construction Materials
    - Well Decommissioning
    - Bulk Material Quantities

- Transportation
    - Personnel Transportation – Road
        - Trip 1 – UXO Techs, car travel to and from site. Assume a car, gasoline. 100 miles one-way * 2 = 200 miles round trip, 2 trip (since there are 2 UXO personnel travelling separately), 1 traveler per car.
        - Trip 2 – UXO Techs, daily travel from hotel to site. Assume light truck, gasoline. 12 miles round trip per day, 5 trips (one for each day of field work at site), 2 travelers in one truck (assuming carpooling from hotel to site).
        - Trip 3 – Geologist (regular field technician), travel to and from site. Assume light truck, gasoline. 200 miles one-way * 2 = 400 miles round trip, 1 trip, 1 traveler.
        - Trip 4 – Geologist (regular field technician), daily travel from hotel to site. Assume light truck, gasoline. 12 miles round trip per day, 5 trips (one for each day of field work at site), 1 traveler.
        - Trip 5 – Subcontractor travel to and from site. Assume light truck, gasoline. 50 miles one-way * 2 = 100 miles round trip, 5 trips, 2 travelers.
    - Personnel Transportation – Air
        - Trip 1 – UXO Techs, plane travel to and from site. 700 miles one-way * 2 = 1400 miles round trip, 2 traveler, 1 flight each.
    - Personnel Transportation – Rail
    - Equipment Transportation – Road
        - Trip 1 – Excavator transport to and from site. Assume diesel, 50 miles one-way * 2 = 100 miles round trip, ~10 tons.
        - Trip 2 – Empty return trips for excavator transport to and from site. Assume diesel, 50 miles one-way * 2 = 100 miles round trip, 0 tons.
    - Equipment Transportation – Air
        - Trip 1 – Empty coolers and bottles sent from lab to site for MC sampling. Assume 1600 miles, 10 lbs per cooler * 22 coolers / 2000 lbs per ton = 0.11 tons.
        - Trip 2 – Full coolers with samples sent from site to lab. Assume 1600 miles, 50 lbs per cooler * 22 coolers / 2000 lbs per ton = 0.55 tons.
    - Equipment Transportation – Rail
    - Equipment Transportation – Water

- Equipment Use
    - Earthwork

        - Equipment 1 – Excavator use for excavation of contaminated soil. Select excavator, diesel, 200 cubic yards.
        - Equipment 2 – Excavator use for backfill with soil from on-site borrow area. Select excavator, diesel; 200 cubic yards of soil will be used; 300 cubic yards entered into SiteWise to account for added excavator use for on-site transport of soil from borrow area and compaction of excavated area.
    - Drilling
    - Trenching
    - Pump Operation
    - Diesel and Gasoline Pumps
    - Blower, Compressor, Mixer, and Other Equipment
    - Generators
    - Agricultural Equipment
    - Capping Equipment
    - Mixing Equipment
    - Internal Combustion Engines
    - Other Fueled Equipment
    - Operator Labor
    - Laboratory Analysis
    - Other Known Onsite Activities

- Residual Handling
    - Residue Disposal/Recycling
        - Soil Residue – Excavated soil requiring disposal. Since the weight carried by a truck in SiteWise cannot exceed 40 tons, the 300 tons of soil will need to be divided equally between 8 trips to keep the transport weight under 40 tons. Enter 37.5 tons, diesel, 8 trips, 50 miles per trip.
        - Residual Water – Empty return trips for soil disposal. Enter 0 tons, diesel, 8 trips, 50 miles per trip.
    - Landfill Operations
    - Thermal/Catalytic Oxidizers

- Resource Consumption
    - Water Consumption
    - Onsite Land and Water Resource Consumption

Once SiteWise input is complete, go to "SiteWise_Input Sheet" for overall project and enter information (including Alternative File Name "MC 3 PDS"). Then go to "Generate Alternative" tab and click button labeled "Click to generate alternative using previously entered alternative name". Copies of the input and output summary sheets for this alternative are now located in the directory titled "RA_MC 3 PDS_NoFR_1". To store the "Remedial Action Construction.xls" calculation sheet showing detailed calculations, open it in the overall SiteWise project directory when the appropriate input sheet is open, then do a "save as" to put it in the directory for this alternative using a name that indicates "will not update". Then open that file and do "data->edit links" and break the links. If the input sheet for this alternative ever changes, then this calculation sheet needs to be re-saved.

MC Alternative 3 at PDS – Removal with Off-Site Disposal Fieldwork

To edit input parameters for this alternative, you must go back to the ORIGINAL SiteWise input sheet and import this alternative using the "Do you want to reload a previously saved remedial alternative in the SiteWise input sheet?" field on the "Site Info" tab. After making necessary changes to the input sheet, re-export the alternative by going to the "Generate Alternative" tab and clicking the button labeled "Click to replace an existing alternative with the same name". Update saved calculation sheets as described above.

Other Supporting Calculations:
MC Alternative 3 at the Possible Demolition Site MRS

% of Total Energy Usage from Renewable Resources

- None identified

Hazardous Air Pollutants

- None identified

Refined Materials Use

- None identified

Unrefined Materials Use

- None identified (the fill is from on-site and is not considered to a be "materials use")

Tons of Non-Hazardous Waste

- 200 cubic yards x 1.5 tons per cubic yard = 300 tons

Tons of Hazardous Waste

- None identified

% of Potential Waste Recycled

- N/A

Risks to On-Site Workers and from Transportation

- Based on SiteWise output
    - On-Site worker injuries or fatalities = 0.0001
    - Transportation related injuries or fatalities = 0.0019

Heavy Truck Trips through Residential Areas

- None identified

Project: GSR Pilot for IAAAP
Option or Alternative: MC Alternative 3 at Possible Demolition Site
Current Date: 4/10/2012

year	up-front cost	annual cost	present value of cost each year	cumulative cash flow	
		(no discounting)	2.3%	no discounting	2.3%
0	$231,029	$0	$231,029	$231,029	$231,029
1	$0	$0	$0	$231,029	$231,029
2	$0	$0	$0	$231,029	$231,029
3	$0	$0	$0	$231,029	$231,029
4	$0	$0	$0	$231,029	$231,029
5	$0	$6,210	$5,543	$237,239	$236,572
6	$0	$0	$0	$237,239	$236,572
7	$0	$0	$0	$237,239	$236,572
8	$0	$0	$0	$237,239	$236,572
9	$0	$0	$0	$237,239	$236,572
10	$0	$6,210	$4,947	$243,449	$241,519
11	$0	$0	$0	$243,449	$241,519
12	$0	$0	$0	$243,449	$241,519
13	$0	$0	$0	$243,449	$241,519
14	$0	$0	$0	$243,449	$241,519
15	$0	$6,210	$4,415	$249,659	$245,934
16	$0	$0	$0	$249,659	$245,934
17	$0	$0	$0	$249,659	$245,934
18	$0	$0	$0	$249,659	$245,934
19	$0	$0	$0	$249,659	$245,934
20	$0	$6,210	$3,941	$255,869	$249,875
21	$0	$0	$0	$255,869	$249,875
22	$0	$0	$0	$255,869	$249,875
23	$0	$0	$0	$255,869	$249,875
24	$0	$0	$0	$255,869	$249,875
25	$0	$6,210	$3,517	$262,079	$253,392
26	$0	$0	$0	$262,079	$253,392
27	$0	$0	$0	$262,079	$253,392
28	$0	$0	$0	$262,079	$253,392
29	$0	$0	$0	$262,079	$253,392
30	$0	$6,210	$3,139	$268,289	$256,531

*positive dollar value is a "cost", negative dollar value is a "savings"

Net Present Value (NPV)-> $256,531

Total of capital costs (undiscounted) -> $231,029
Total of annual costs (undiscounted) -> $37,260

GSR Team Calculations to Split Energy Results from SiteWise into "Direct" and "Indirect"
MC Alternative 3 at the PDS MRS

phase	Reported by SiteWise: activity	Reported by SiteWise: energy used (MMBTU)	Assigned by GSR Team from SiteWise Output: Scope 1 (direct) energy used (MMBTU)	Scope 2 (indirect) energy used (MMBTU)	Scope 3 (indirect) energy used (MMBTU)	Total Calculated by GSR Team
Removal with Off-Site Disposal Fieldwork ("Remedial Action Construction" tab)	Consumables	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	16.97	0.00	0.00	16.97	16.97
	Transportation-Equipment	14.10	0.00	0.00	14.10	14.10
	Equipment Use and Misc	3.15	2.55	0.00	0.60	3.15
	Residual Handling	22.61	0.00	0.00	22.61	22.61
	Sub-Total	56.83	2.55	0.00	54.28	56.83
total		56.83	2.55	0.00	54.28	56.83

Note: Electricity use reported by SiteWise Version 2.0 in units of kWh is "Direct Scope 1", meaning it is energy consumed at the location of the project. However, energy use associated with electricity reported by SiteWise in units of MMBtu is a life-cycle value which also includes a factor to account for energy used elsewhere required to generate the electricity ("Indirect Scope 2"). Here, 33% of the life-cycle value reported by SiteWise is considered to be "Scope 1" on-site energy use, and 67% is considered to be "Scope 2" energy used in electricity generation.

SiteWise Version 2.0 uses fuel energy values from U.S. Department of Energy, Argonne National Laboratory, Transportation Technology R&D Center, GREET 1.8d.1, Fuel-Cycle model, 2010. This version of the GREET model reports that for Gasoline and Diesel, approximately 19% of GHG emissions are upstream emissions (scope 3) and 81% are tailpipe emissions (scope 1). For this analysis, it is assumed that energy is used in these same proportions, and therefore the energy use reported by SiteWise is split between scope 3 and scope 1 in these ratios.

GSR Team Calculations to Split GHG Results from SiteWise into "Direct" and "Indirect"
MC Alternative 3 at the PDS MRS

phase	Reported by SiteWise activity	Reported by SiteWise GHG emitted (metric tons CO2e)	Assigned by GSR Team from SiteWise Output: Scope 1 (direct) GHG emitted (metric tons CO2e)	Scope 2 (indirect) GHG emitted (metric tons CO2e)	Scope 3 (indirect) GHG emitted (metric tons CO2e)	Total Calculated by GSR Team
Removal with Off-Site Disposal Fieldwork ("Remedial Action Construction" tab)	Consumables	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	1.31	0.00	0.00	1.31	1.31
	Transportation-Equipment	1.75	0.00	0.00	1.75	1.75
	Equipment Use and Misc	0.17	0.14	0.00	0.03	0.17
	Residual Handling	1.73	0.00	0.00	1.73	1.73
	Sub-Total	4.97	0.14	0.00	4.83	4.97
Total		4.97	0.14	0.00	4.83	4.97

Note: CO2e reported by SiteWise Version 2.0 for electricity use is all associated with generation of the electricity ("Indirect Scope 2").

SiteWise Version 2.0 use fuel emission factors from U.S. Department of Energy, Argonne National Laboratory, Transportation Technology R&D Center, GREET 1.8d.1, Fuel-Cycle model, 2010. This version of the GREET model reports that for gasoline and diesel, approximately 19% of GHG emissions are upstream emissions (Scope 3) and 81% are tailpipe emissions (Scope 1). For this analysis, the GHG emissions reported by SiteWise are split between Scope 3 and Scope 1 in these ratios.

FINAL REPORT

PILOT PROJECT
GREEN AND SUSTAINABLE REMEDIATION EVALUATION:
LAKE CITY ARMY AMMUNITION PLANT (LCAAP)
INDEPENDENCE, MISSOURI

Prepared for:

U.S. Army Corps of Engineers
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Contract No. W912DQ-08-D-0019
Delivery Order No. ZW02

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26 January 2012

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PREFACE

The US Army Engineering and Support Center, Huntsville (USAESCH), Environmental and Munitions Center of Expertise (EM CX) has contracted Tetra Tech EC, Inc. (Tetra Tech) under Contract W912DQ-08-D-0019, Delivery Order No. ZW02, to conduct and document a Study that follows the process of considering, incorporating, documenting, and evaluating the benefits of green and sustainable remediation (GSR) practices. The objective of this Task Order is to: (1) Follow the consideration and incorporation of GSR practices into Army environmental remediation projects; (2) Ascertain the effectiveness of the GSR practices that are considered and incorporated; and (3) Provide procedures by which GSR practices that are shown to be effective can be identified, considered, implemented and documented by Project Teams working on Army sites. The information obtained from this Study will be used to provide recommendations to the Office of the Assistant Chief of Staff for Installation Management (OACSIM) for development of Army-wide GSR guidance and policy. This document has been prepared in accordance with the Task Order Statement of Work (SOW) entitled "*Evaluation of Consideration and Incorporation of Green and Sustainable Remediation (GSR) Practices in Army Environmental Remediation*" (26 July 2010).

The Project Delivery Team (PDT) consists of representatives and subject matter experts (SMEs) from the following organizations:

- EM CX;
- OACSIM;
- National Guard Bureau (NGB);
- Army Environmental Command (AEC);
- Tetra Tech;
- Office of the Deputy Assistant Secretary of the Army-Environment, Safety, and Occupational Health (ODASA (ESOH));
- Headquarters US Army Corps of Engineers (HQ USACE) Formerly Used Defense Sites (FUDS) program;
- HQ USACE Environmental Community of Practice (ECoP) Military Munitions Support Services (M2S2);
- Huntsville Center Environmental Program; and
- Army Environmental Policy Institute (AEPI)

Specific representatives of those organizations are listed on the table at the end of this preface. This report pertains to one of the pilot projects conducted as part of the Study. Tetra Tech personnel who provided the most significant contributions to this report are as follows:

- Preparation
    - Rob Greenwald (Project Manager)
    - Sarah Farron

- Review
    - Doug Sutton (IRP GSR Technical Lead)

Sincere thanks are extended to Project Team associated with this pilot project, for their willingness to participate in this Study and for their efforts that were associated with their participation.

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Professional in Charge:

Doug Sutton, PhD, PE, LEED

1/26/12
Date

ACRONYMS AND ABBREVIATIONS

ACSIM	Assistant Chief of Staff for Installation Management
AEC	Army Environmental Command
AEPI	Army Environmental Policy Institute
AOC	Area of Concern
ATK	Alliant Techsystems, Inc.
BMPs	Best Management Practices
CATOX	Catalytic oxidizer
CO2	Carbon dioxide
CO2e	Equivalent Global Warming Potential of Carbon Dioxide
COCs	Constituents of Concern
CSM	Conceptual Site Model
1,2-DCE	1,2-Dichloroethene
DNAPL	Dense Non-Aqueous Phase Liquid
DoD	Department of Defense
ECoP	Environmental Community of Practice
EQ	Equalization
ERD	Enhanced Reductive Dechlorination
EM CX	Environmental and Munitions Center of Expertise
ESOH	Environment, Safety, and Occupational Health
FUDS	Formerly Used Defense Sites
GHG	Greenhouse gas
gpm	Gallons per Minute
GSR	Green and Sustainable Remediation
HP	Horsepower
HQ USACE	Headquarters US Army Corps of Engineers
HRS	Hours
IRACR	Interim Remedial Action Completion Report
IRP	Installation Restoration Program
IRZ	In-situ Reactive Zone
IWOU	Installation-Wide OU
IWTP	Industrial Wastewater Treatment Plant
Kg	Kilograms
lbs	Pounds
LCAAP	Lake City Army Ammunition Plant
LTM	Long Term Monitoring
LNAPL	Light Non-Aqueous Phase Liquid
M2S2	Military Munitions Support Services
MCF	Thousand Cubic Feet
MMBtu	Million Metric British Thermal Units
MMRP	Military Munitions Response Program
MNA	Monitored Natural Attenuation
mo	Month
NAPL	Non-Aqueous Phase Liquid
NECOU	Northeast Corner OU
NGB	National Guard Bureau
NOx	Nitrogen Oxides
NPV	Net present value
O&M	Operations and Maintenance

OACSIM	Office of the Assistant Chief of Staff for Installation Management
ODASA	Office of the Deputy Assistant Secretary of the Army
OUs	Operable Units
P&T	Pump and Treat
PBC	Performance Based Contract
PCBs	Polychlorinated Biphenyls
PCE	Tetrachloroethene
PDT	Project Delivery Team
PLC	Programmable Logic Controller
PM	Particulate Matter
POTW	Publicly Operated Treatment Works
PRW	Permeable Reactive Wall
RD/RAWP	Remedial Design/Remedial Action Work Plan
RECs	Renewable Energy Certificates
RI	Remedial Investigation
ROD	Record of Decision
RSE	Remediation System Evaluation
SiteWise	Battelle SiteWise™ Sustainable Environmental Remediation Tool
SMEs	Subject matter experts
SOW	Statement of Work
SOx	Sulfur Oxides
SVOCs	Semivolatile Organic Compounds
TCE	Trichloroethene
TI	Technical Impracticability
ug/l	Micrograms per Liter
US	United States
USACE	United States Army Corps of Engineers
USAESCH	US Army Engineering and Support Center, Huntsville
VC	Vinyl Chloride
VFD	Variable Frequency Drive
VOCs	Volatile Organic Compounds
ZVI	Zero-Valent Iron

1.0 INTRODUCTION

1.1 ACSIM GSR STUDY AND PURPOSE OF THIS GSR EVALUATION

The US Army Engineering and Support Center, Huntsville (USAESCH), Environmental and Munitions Center of Expertise (EM CX) has contracted Tetra Tech EC, Inc. (Tetra Tech) under Contract W912DQ-08-D-0019, Delivery Order No. ZW02, to conduct and document a Study that follows the process of considering, incorporating, documenting, and evaluating the benefits of green and sustainable remediation (GSR) practices (hereafter referred to as "the Study"). Pursuant to the Department of Defense (DoD) Memorandum "*Consideration of Green and Sustainable Remediation Practices in the Defense Environmental Restoration Program*" (DoD, 2009), GSR employs strategies throughout the remedial process that:

- Use natural resources and energy efficiently;
- Reduce negative impacts on the environment;
- Minimize or eliminate pollution at its source;
- Protect and benefit the community at large; and
- Reduce waste to the greatest extent possible.

The objective of the Study is to: (1) Follow the consideration and incorporation of GSR practices into Army environmental remediation projects; (2) Ascertain the effectiveness of the GSR practices that are considered and incorporated; and (3) Provide procedures by which GSR practices that are shown to be effective can be identified, considered, implemented and documented by project teams working on Army sites. The information obtained from this Study will be used to provide recommendations to the Office of the Assistant Chief of Staff for Installation Management (OACSIM) for development of Army-wide GSR guidance and policy.

One component of the Study described above is to perform a GSR evaluation at 12 Army "Pilot Projects" that are in various phases of the remedial process. One purpose for the pilot projects is to provide testing of the GSR approach developed during the Study. That approach will be refined and finalized later in the Study based on lessons learned from this and other pilot projects. In addition, it is anticipated that this GSR evaluation will provide the Project Team for LCAAP with information and/or recommendations that will be beneficial for their project.

This report presents a Pilot Project GSR Evaluation for the Lake City Army Ammunition Plant (LCAAP) in Independence, Missouri (hereafter referred to as "LCAAP"). This GSR evaluation has been conducted using a general approach developed during the Study and documented in the following report: *Process for Consideration and Incorporation of Green and Sustainable Remediation (GSR) Practices in Army Environmental Remediation (26 May 2011)*. The information for this GSR evaluation was obtained from a recently completed Remediation System Evaluation (RSE) report (dated 27 May 2011).

This report refers to "teams" that are defined as follows:

- Study Team: This is the team conducting the Study being led by USACE EM CX that follows the process of considering, incorporating, documenting, and evaluating the benefits of green and sustainable remediation practices for Army projects.

- Project Team: Refers to those associated with implementation of the remedial process for the pilot projects.

- GSR Team: Refers to the personnel that perform a specific GSR evaluation. For this Study, the GSR Team consists of personnel from Tetra Tech, which is a contractor to USACE for the Study.

In this Study, an "EM CX liaison" for each of the pilot projects serves as a bridge between the USACE Study project manager (Carol Dona), the Study contractor performing the GSR evaluation (Tetra Tech), and the Project Team manager for the specific pilot.   For this pilot project the EM CX Liaison is Carol Dona.

1.2 TECHNICAL OVERVIEW: LCAAP

1.2.1 <u>Overview of Site Location, Setting, and Contamination</u>

LCAAP is a 3,935-acre government owned, contractor operated facility located at the intersection of U.S. Highways 7 and 78, between Independence and Blue Springs, Missouri. The LCAAP is mostly bordered by woodlands or agricultural land. The site was originally used as farmland prior to establishment, and the major use of the adjacent land continues to be agriculture-related. The Missouri River is located north of LCAAP. The LCAAP is divided into many different "Areas", and remediation is organized into Operable Units (OUs). The various Areas and OUs at LCAAP are illustrated on Figure 1-1, including the following:

- Installation-Wide OU, or IWOU – also called "OU1"
- Area 18 OU – also called "OU2"
- Northeast Corner OU, or NECOU (consists of Area 11, Area 16, and Area 17) – also called "OU3"
- Area 10 OU – also called "OU4"

The LCAAP was established in 1941 to manufacture and test small caliber ammunition for the Army and has remained in continuous operation except for one 5-year period from 1946 to 1950. The LCAAP is the only major small arms manufacturing facility for the Army. Due to its unique position as the only small arms ammunition manufacturing facility, there is no plan to cease production in the near future. Operations at the LCAAP include manufacture, assembly, storage and test firing of small caliber ammunition. Infrastructure operations include wastewater treatment; hazardous waste storage, treatment and disposal; municipal/industrial solid waste and sludge disposal; and incineration/demilitarization of ammunition. Industrial operations have generated large quantities of potentially hazardous wastes and hazardous substances. Typical commercial chemicals used at the LCAAP include soaps, detergents, bleaches, acids, pyrotechnics, metals, phosphate cleaners, oils, explosive compounds and solvents. Contaminants of concern at the LCAAP include volatile (VOCs) and semivolatile organic compounds (SVOCs), metals, perchlorate, polychlorinated biphenyls (PCBs) and explosives.

Historically, waste treatment and disposal at the LCAAP occurred on site in lagoons, landfills and burn pits, which are the focus of the ongoing cleanup actions at each of the OUs. Area 16 contains the abandoned landfill, solvent pits, old burning ground area, and a closed firing range. Area 17 contains three closed oil and solvent pits; a waste, glass, paint, and solvents area; an old burning pad; the closed sanitary landfill; and the active pistol qualifying range. Area 18 contains eight surface impoundments that were used to burn waste grease and oil from the industrial wastewater treatment plant (IWTP), solvents, and trash. Fifteen other pits located throughout the area were used for burning and disposal of IWTP and other wastes.

This GSR evaluation focuses on the following plumes at LCAAP that were described in the previously performed RSE:

- Area 12 (OU1)
- Area 18 (OU2)
- Area 16B (OU3)
- Area 17B (OU3)
- Area 17D (OU3)

The primary constituents of concern (COCs) in these areas are Tetrachloroethene (PCE), Trichloroethene (TCE), and/or daughter products of those compounds such as 1,2-Dichloroethene (1,2-DCE) and vinyl chloride (VC). A plume map for at least one of the COCs in each of these areas is presented in the following figures to provide the reader with a general overview of the plume extent:

- Area 12: Figure 1-2
- Area 18: Figures 1-3 to 1-5
- Area 16B: Figure 1-7
- Area 17B: Figure 1-8
- Area 17D: Figure 1-9

Note there are maps for other COCs in site reports. In some of these areas (such as Area 17B and Area 18) there is non-aqueous phase liquid (NAPL) present, which is consistent with very high concentrations of VOCs that are observed (in some cases concentrations of individual VOC constituents are greater than 100,000 ug/l). The presence of daughter products (1,2-DCE and vinyl chloride) indicates that reductive dechlorination occurs at the site, and in all of the areas listed above one of the groundwater remedy components is to apply enhanced reductive dechlorination (ERD) via addition of carbon substrate.

1.2.2 Remedial Phase and Status

LCAAP has a variety of operating groundwater remedies that have been implemented in different OUs including pump-and-treat (P&T) with air stripping, enhanced reductive dechlorination (ERD) via injection of organic carbon substrate, a permeable reactive wall (PRW), phytoremediation, and monitored natural attenuation (MNA). Alliant Techsystems, Inc. (ATK) is the Facility Use Contractor, and they operate the pumping wells and treatment plants that are associated with P&T operations at LCAAP. ARCADIS performs the in-situ components of the remediation as part of its performance based contract (PBC) with the Army. The existing PBC expires on Sept. 10, 2012. The PBC covers different types of work at many different "sites" across LCAAP, and all work that has been managed under the PBC will revert back to the individual "site" funding upon contract expiration in September 2012.

Please note that this GSR evaluation specifically addresses the existing P&T systems at LCAAP. In addition, this GSR evaluation includes a "generic" footprint evaluation of different substrate options for ERD. Historically, molasses and molwhey (a mixture of molasses and cheese whey) have been used at LCAAP for ERD, with different injection frequencies and concentrations over time. The recently performed RSE recommended consideration of vegetable oil because it generally has a longer half-life than molasses or molwhey. For this GSR evaluation, a quantitative footprint analysis is included for a case study that assumes different injection frequencies for each of these substrate options, based on the half-life assumed for each substrate.

1.2.2.1 Overview of Operating Groundwater Remedies

Active remediation components that were addressed in the previously performed RSE include the following:

- OU1 (Installation-Wide OU) - The RSE considered the following active components of OU1 (illustrated on Figure 1-2):
    - Area 12: One groundwater production well (well 17AA) with an air stripper, with discharge to the Industrial Wastewater Treatment Plant (IWTP)
    - ERD via one line of injection wells
- Other Water Supply Wells with Treatment Via Air Strippers – In addition to supply well 17AA (Area 12), there are six other supply wells that are pre-treated with air strippers prior to discharge to the IWTP. Whereas well 17AA is part of OU1, the other six supply wells connected to air strippers are not part of any OU or any formal remedy. In total, there are seven supply wells (including 17AA) pre-treated by five strippers.
- OU2 (Area 18 OU) – The overall layout of Area 18 is illustrated on Figure 1-3. The RSE considered the following active components of OU2 (illustrated on Figure 1-5):
    - Two groundwater extraction wells (17FF and 17R) with treatment at the Building 163 air stripper (which also treats water from extraction well 17S from OU3).
    - NAPL removal in the AOC 1/North Pit source area, and in the AOC 2/AOC 3 source area (to be converted in the future to ERD injection locations).
    - ERD via one line of injection wells northeast of the AOC 1/North Pit source area, and via one line of injection wells northwest of the AOC 2/AOC 3 source area.
- OU3 (Northeast Corner Operable Unit, or NECOU) – This OU consists of multiple areas including Area 16B, 17B, and 17D. The relative location of these areas is illustrated on Figure 1-6. The RSE considered the following active components of OU3:
    - Area 16B – ERD via one line of injection wells (Figure 1-7)
    - Area 17B – ERD via five lines of injection wells, plus zero-valent iron (ZVI) treatment of the source area (Figure 1-8)
    - Area 17D – Multiple active technologies (Figure 1-9):
        - ERD via three lines of injection wells
        - Permeable reactive wall (PRW)

- Phytoremediation upgradient of the barrier wall

- One groundwater extraction well (17S) near the northern LCAAP boundary to contain potential off-site plume migration, with treatment at the Building 163 air stripper

1.2.2.2 Overview of Groundwater Extraction Remedies

A list of groundwater extraction wells where "pre-treatment" of water is currently performed is presented in Table 1-1. The term "pre-treatment" is used because in all cases the water that is treated is subsequently treated again. In the case of the supply wells, the treated water is sent to the centralized IWTP where it runs through an aerator. For the wells that feed into the Building 163 stripper, the treated water goes to the POTW. Note that the extraction pumps are likely oversized.

Table 1-1
List of Extraction Wells With Some "Pre-Treatment" of the Water for VOCs

OU	Well Name	Location/Description	Pump HP**	Typical Extraction Rate (gpm)	Air Stripper
1	17AA	Area 12, supply well also used for plume containment	15-20	~ 250	Shared*
-	17CC	Supply well	15-20	~ 250	
-	17BB	Supply well	15-20	200***	Stand-alone*
-	17EE	Supply well	15-20	200***	Stand-alone*
-	17JJ	Supply well	15-20	200***	Stand-alone*
-	17K	Supply well	15-20	200***	Shared*
-	17KK	Supply well	15-20	200***	
2	17R	Area 18 – between and just north of the two source areas	~15	~ 105****	Bldg 163
2	17 FF	Area 18 - north of toe of plume	~10	~ 70****	Bldg 163
3	17S	Area 17D – at northern facility boundary	~15	~100****	Bldg 163

**water from these strippers then goes to the aerator at the IWTP*
***pump horsepower (HP) estimates provided by Ron Brennecke (ATK) during RSE site visit*
****rate assumed by RSE team, this information was not available in documents provided*
*****rates shown reflect reductions in flow implemented in 2011. Flows at the time of the RSE site visit were: 17R - ~125, 17FF - ~90, and 17S - ~125 gpm.*

Additional notes about the extraction wells provided in the RSE site report include the following:

- At supply well 17AA in Area 12, the remedy reportedly requires only 50 gpm of pumping (based on modeling) for addressing plume containment as per the Record of Decision (ROD), but a higher rate (~240 gpm based on the IRACR) is actually extracted from well 17AA for use as water supply.

- Wells 17K and 17KK operate one-at-a-time.

- Flow meters are located at the well houses for each well.

- The RSE team was not able to determine pumping rates at many of the supply wells, but was told during the RSE site visit that the total pumping at the supply wells is between 1,000 and 2,000 gpm.

- The three wells treated at Building 163 (17R, 17FF, and 17S) are controlled to achieve a target flow rate using a valve that is operated at the Programmable Logic Controller (PLC).

- The pumps for the extraction wells do not have variable frequency drives (VFDs).

1.2.2.3 Overview of Treatment for Extracted Groundwater

<u>Building 163 Air Stripper with Discharge to POTW</u>

This system is used to treat water from wells 17R and 17FF in Area 18 (OU2) and from well 17S in Area 17D (OU3). At the time of the RSE the influent flow rate was approximately 340 gpm. Recently the combined influent flow rate from 17R, 17FF, and 17S has been reduced to approximately 275 gpm (as shown in Table 1-1 above). Based on 2008 data the influent concentration of total VOCs (based on TCE, 1,2-DCE, and VC) was on the order of 350 ug/l. The treatment process is as follows:

- Water enters the equalization (EQ) tank from the extraction wells (except for some water that is periodically diverted for ERD injections). The plant operator indicated that without the EQ tank balancing the overall flow rate through the plant, the discharge sump would flood. Water from wells 17R and 17FF enters the treatment plant in a combined line, and water from well 17S enters the plant in a separate line. The piping is single-contained. There are no chemical additions to the water that goes to the air stripper.

- A 25HP pump (there are two pumps, but only one operates at a time) moves the water from the EQ tank to the packed tower air stripper (45 ft packing depth), which uses a 15HP fan.

- From the air stripper water goes to a sump where it is transferred (two 25HP pumps, only one used at a time) to the Little Blue Valley Sewer District POTW.

- Air from the air stripper goes through a knockout tank to remove moisture, and then to a catalytic oxidizer (CATOX) unit with a 25 HP fan to draw air through. The CATOX is powered by natural gas (since the influent vapor concentrations are far too low to power the CATOX). The CATOX has a continuous gas analyzer.

The treatment building also has heaters for the winter, operated using natural gas.

Five Air Strippers for Production Wells (with Discharge to IWTP)

The RSE indicated that the five strippers that are used for seven water supply wells (see Table 1-1), and motors for these five strippers are as follows:

- Combined stripper for 17AA and 17CC - 15 HP blower and 15 HP transfer pump
- Stripper for 17BB - 10 HP blower and 15 HP transfer pump
- Stripper for 17EE - 10 HP blower and 15 HP transfer pump
- Stripper for 17JJ - 10 HP blower and 15 HP transfer pump
- Combined stripper for 17K and 17KK - 10 HP blower and 15 HP transfer pump

The well pumps (see Table 1-1) move the water to the top of the strippers. The transfer pumps (listed above) move water from the sump after each stripper to the IWTP where it is treated with a General Filter forced draft aerator. The design basis and capacity (flow and VOC stripping capacity) of the General Filter forced draft aerator were not provided.

1.2.2.3 Overview of In-Situ Groundwater Treatment

OU1 – Area 12

The Area 12 Layout is illustrated in Figure 1-2. An ERD in-situ reactive zone (IRZ) line was placed approximately mid-plume (the exact plume source is not known). The ERD injection line is upgradient of P&T extraction well 17AA (groundwater flow in this area is from east to west towards the site boundary). The ERD system consists of one transect of five injection wells. Starting in 2008, about 13,000 gallons per well dilute substrate (2% molasses originally, later reduced to 1% molasses) was injected in 5 wells with 3 to 4 injections per year. The injections require an injection pump (5.5 HP). The RSE did not identify if a mixing pump was also utilized, but if so, its use would be very minor. The RSE indicated that injections have recently been discontinued (or at least significantly reduced in frequency) because successful degradation has been observed.

OU2 – Area 18

The locations of the in-situ components of the Area 18 remedy are illustrated on Figure 1-5. These in-situ remedy components include the following:

- ERD Injection Lines - There are two current ERD injection lines:

    - One injection line northeast of the AOC 1/North Pit source area, consisting of 14 injection locations, approximately 15,000 gallons per well of dilute substrate (2% molasses originally, later reduced to 1% molasses)

    - One injection line northwest of the AOC 2/AOC 3 source area, consisting of 15 injection locations, approximately 23,000 gallons per well of dilute substrate (2% molasses originally, later reduced to 1% molasses)

  These injection lines are located based on the assumption that groundwater is pulled from the two source areas towards recovery well 17R. The injection batches are mixed in Building 163 (the treatment building for Area 18) using water from the P&T extraction wells, and are distributed via a 5.5 HP injection pump in Building 163. There are two injections per year, which each require 2.5 weeks for injection. ERD application time frames are now estimated at 17 yrs for AOC 1/North Pit and 35 yrs for AOC 2/AOC 3.

- Shallow Wells for NAPL Recovery - There are 130 shallow wells that were installed for NAPL recovery (most are located near the AOC 2/AOC 3 source area for DNAPL recovery, though some are located near the AOC 1/North Pit source area for LNAPL recovery). The draft five-year review (April 2010) indicates the following NAPL removal:

  - through the third quarter 2008, approximately 12 gallons from the AOC 1 and North Pit wells and approximately 95 gallons from the AOC 2 and AOC 3 wells

  - through the fourth quarter 2008, approximately 18 gallons from the AOC 1 and North Pit wells and approximately 123 gallons from the AOC 2 and AOC 3 wells

  - through the first quarter 2009, approximately 19 gallons from the AOC 1 and North Pit wells and approximately 136 gallons from the AOC 2 and AOC 3 wells

  - through the second quarter 2009, approximately 19 gallons from the AOC 1 and North Pit wells and approximately 146 gallons from the AOC 2 and AOC 3 wells

  - through the third quarter 2009, approximately 20 gallons from the AOC 1 and North Pit wells and approximately 175 gallons from the AOC 2 and AOC 3 wells

  This suggests there is very little ongoing LNAPL recovery from the AOC 1/North Pit source area, and some continuing DNAPL recovery from the AOC 2/AOC 3 source area. There are plans to utilize many of these shallow wells as additional ERD injection wells in the near future.

OU3 – Area 16B

The Area 16B layout is illustrated in Figure 1-7, and includes ERD via one line of 5 injection wells. This injection line is fed by gravity (i.e., no injection pump is required). The injection wells are spaced 20 feet apart. Operation was initiated in 2008, and the injections are approximately 1,000 to 2,000 gallons per well of dilute substrate (2% molasses), approximately once per year.

OU3 – Area 17B

The locations of the in-situ components of the Area 17B remedy are illustrated on Figure 1-8. These in-situ remedy components include the following:

- ERD Injection Lines - There are five current ERD injection lines oriented perpendicular to groundwater flow:

  - Lines 1 through 4 (32 injection points total) are intended to address the source area. These lines are installed in weathered bedrock and do not accept injections well. The molasses solution is mixed at Building 152 and delivered to these four injection lines via a 7.5 HP pump. Approximately 300 to 700 gallons per well have been injected approximately twice per year. The project team has recently been testing injection with pressure into the 4 upgradient IRZ lines.

- Line 5 (8 injection points total) is intended to provide a cutoff barrier for the downgradient portion of the plume, prior to the discharge of groundwater to the subsurface paleochannel feature. This line takes injection much better than lines 1 to 4. Injections are approximately 1,000 gallons per well of dilute substrate (4% molasses, previously 2% molasses), occur approximately quarterly, and require approximately 5 weeks each. These injections in Line 5 are performed using a 0.75 HP pump.

- Source area treatment via soil mixing with ZVI/clay in a 4,500 square foot area in portions of the source area where data from nearby wells and soil borings indicated the presence of drainable and residual NAPL. After soil mixing, the disturbed area was restored to premixing condition, including replacement of a soil cover over the mixed areas of the pits and any areas disturbed by silt fence placement. ZVI is intended to reduce source area concentrations as well as reduce hydraulic conductivity of the treated aquifer material (to minimize dissolution of remaining mass).

This in-situ approach in Area 17B has an indefinite time span for source area cleanup, with the latest estimate of more than 400 years. ARCADIS applied for a Technical Impracticability (TI) waiver for cleanup of the source area in a report dated October 2009, but the application was not accepted by EPA (which indicated, among other things, that other source area remediation technologies could be attempted).

<u>OU3 – Area 17D</u>

Area 17D is located on the opposite (i.e., southwest) side of Abshier Creek from Area 17B. The locations of in-situ components of the Area 17D remedy are illustrated on Figure 1-9. These in-situ remedy components include the following:

- A permeable reactive wall (PRW) was placed in the downgradient (i.e., northwestern) portion of the Area 17D plume to prevent migration of the impacted groundwater into the subsurface paleochannel feature. However, the PRW caused groundwater to mound behind it, possibly a result of smearing during construction. Phytoremediation was added upgradient of the PRW in an attempt to reduce the mounding of water behind the wall, with good results reported.

- ERD Injection Lines - There are three current ERD injection lines:

    - The easternmost (i.e., furthest upgradient) line has 5 injection points located parallel to groundwater flow, in the most concentrated portion of the plume.

    - The two other lines consist of a total of 8 injection points. Each of those two lines is perpendicular to groundwater flow.

  The injections are approximately 3,000 gallons per well of dilute substrate (4% molasses, previously 2% molasses), and occur approximately quarterly. The molasses is mixed at Building 152 and delivered to a storage tank in the "gravity area" via a 7.5 HP pump. The actual injection is then performed via gravity. The RSE team did not note how long these injections take.

1.3 DOCUMENTS REVIEWED AND CALLS/MEETINGS CONDUCTED

The following project documents were reviewed for this evaluation:

- Remediation System Evaluation (May 27, 2011)

The RSE was based on review of many more site documents that are referenced in the RSE report. For this pilot project, a Pre-Draft report was completed based on the RSE report, and the Pre-Draft report was provided to the Project Team for review. Comments regarding the Pre-Draft were discussed on a conference call held on 28 November 2011. This approach takes the place of the following calls typically performed for pilot projects in this Study:

- Introductory conference call (referred to as the "Step 3" call in this Study)
- More detailed phone call where pertinent information for the GSR evaluation is discussed (referred to as the "Step 5" call in this Study)

Participants on the call that occurred on 28 November 2011 are listed in Table 1-2.

Table 1-2
Call Participants, 28 November 2011

Participants			
Name	**Organization**	**Phone**	**Email**
Carol Dona	EM CX	402.697.2582	Carol.L.Dona@usace.army.mil
Rob Greenwald	TT	732.409.0344	rob.greenwald@tetratech.com
Sarah Farron	TT	732.409.0344	sarah.farron@tetratech.com
Sara Clark-Kennedy	US Army	816.796.7159	sara.b.clark-kennedy.civ@mail.mil
Jonathan Harrington	AEC	210.466.1719	jonathan.harrington2.civ@mail.mil

1.4 STRUCTURE OF THIS REPORT

This GSR evaluation report is structured as follows:

- Section 1: Introduction
- Section 2: Key GSR Findings
    - Review of BMPs
    - Quantitative Footprint Analysis for Current P&T Remedies (Baseline)
    - Quantitative Footprint Analysis for Potential Alternatives for P&T Remedies
        - Alternative 1 - Eliminate CATOX at Building 163
        - Alternative 2 - Eliminate Individual Water Supply Well Strippers
        - Alternative 3 - Direct Discharge to POTW from 17S, 17FF, And 17R

        - Alternative 4 - Treatment of All Water at On-Site Treatment Plant for use as water supply, with no Pre-Treatment at Building 163
    - Case Study Footprint Analyses of Molasses, Molwhey, and Vegetable Oil
    - Other Qualitative Considerations
- Section 3: GSR Recommendations

Supporting information and calculations for quantitative aspects of the evaluation are provided in appendices, and spreadsheet files for the SiteWise tool are attached electronically.

2.0 KEY GSR FINDINGS

2.1 REVIEW OF BEST MANAGEMENT PRACTICES (BMPs)

2.1.1 BMP Tables Completed by GSR Team

The GSR Team used a list of GSR BMPs as an outline to summarize ideas pertinent to application of GSR practices for this pilot project. The GSR Team subsequently completed the BMP tables included in Appendix A, based on the data provided in the RSE report (augmented in some cases by information provided on the 28 November 2011 call). Table 2-1 summarizes information entered on the BMP tables in Appendix A, specifically with respect to the number of BMPs that appear to be applicable for this pilot project, the number of BMPs that appear to be practical for this pilot project, the number of BMPs that have been implemented prior to this GSR evaluation, and the number of BMPs that maybe associated with potential cost savings for this pilot project.

Table 2-1
Summary of BMP Applicability and Implementation from BMP Tables in Appendix A

	BMP Category								
	A. Planning	B. Characterization and/or Remedy Approach	C. Energy/Emissions Transportation	D. Energy/Emissions Equipment Use	E. Materials & Off-site Services	F. Water Resource Use	G. Waste Generation, Disposal, and Recycling	H. Land Use, Ecosystems, and Cultural Resources	I. Safety and Community
Total Number of BMPs	10	9	4	11	5	5	6	7	7
Number of Applicable BMPs	9	7	3	6	5	2	1	1	2
Number of Practical BMPs	7	7	2	0	0	1	0	0	0
Number of BMPs Implemented Prior to GSR Evaluation									
- Fully	2	0	2	0	0	1	0	0	0
- Partially	1	2	0	0	0	0	0	0	0
- Not Yet	4	5	0	0	0	0	0	0	0
Number of Practical BMPs Likely to Result in Cost Savings	4	6	2	0	0	0	0	0	0

Please note that, for this pilot project, GSR BMP tables in Appendix A were filled out for the P&T systems only. Groundwater treatment at LCAAP also includes in-situ treatment, which consists primarily of enhanced reductive dechlorination (ERD) via injection of organic carbon substrate. Although this GSR evaluation includes a generic evaluation of quantitative footprints for three different ERD substrates (molasses, molwhey, and vegetable oil), the major focus of this pilot project GSR evaluation (i.e., for this Study) is the P&T systems, and the evaluation of GSR BMPs was only performed with respect to the P&T systems.

2.1.2 Key Findings Regarding BMPs

An overview of key findings regarding application of the BMPs to this pilot project is provided below.

- With respect the P&T systems, the BMPs that were most applicable pertained to the more general categories such as planning. Some GSR BMPs have already considered or incorporated, and examples include (but are not limited to) the following:
  - Prepare, store, and distribute electronic documents
  - Utilize teleconferences rather than meetings when feasible
  - Integrating schedules to allow for resource sharing (the same staff are used for the operation of the Building 163 and water supply P&T systems)
  - Reducing the number of trips by consolidating P&T system wastes with other Installation wastes
- The BMP tables in Appendix A suggest several items that the Project Team could consider moving forward. Some examples include the following:
  - Develop a culture of GSR, which could include:
    - Incorporating a section on GSR in meetings, work plans, and reports
    - Identifying stakeholder issues and concerns regarding GSR
  - Conduct a thorough review of project and historical documents to minimize required scope of investigation (e.g., the RSE indicates that the discharge limits for the Building 163 treatment system to the POTW were not available for review)
  - Document consideration of recommendations from the optimization evaluation recently performed
  - Confirm appropriateness of remedy approach – for instance, the RSE suggests that it is not clear that treatment of air stripper off gas at Building 163 is actually required
- The BMP tables in Appendix A suggest several items that may not be practical at this time because of other project-specific constraints. Examples include the following:

- The potential to implement variable frequency drives (VFDs) for motors is best evaluated after other recommendations in the RSE are implemented.

- Although the RSE indicated the potential to reduce demand on the POTW (and eliminate associated costs) by discharging water from the Building 163 system to the IWTP rather than the POTW, the Project Team indicated they were unlikely to be pursue that scenario based on funding and regulatory considerations.

2.2 QUANTITATIVE FOOTPRINT ANALYSIS FOR P&T SYSTEMS (BASELINE SCENARIO)

Please note that the quantitative results presented in the GSR evaluation differ slightly from those presented in the previous RSE report. Differences include the following:

- This GSR evaluation utilizes SiteWise Version 2.0, whereas the RSE report used a previous version (SiteWise 1.0). The more recent version of SiteWise uses different "conversion factors" than the previous version, and also allows for some different inputs. For instance, SiteWise Version 2.0 allows natural gas usage for a heater to be entered, whereas SiteWise Version 1.0 did not (rather, energy use in another form other than natural gas had to be input as a surrogate in SiteWise Version 1.0).

- This GSR evaluation breaks out energy use and GHG emissions into "Direct" (i.e., on-site use) and "Indirect" (i.e., off-site production of the energy), whereas the RSE did not make that distinction.

- SiteWise Version 2.0 is more clear that the blower associated with the CATOX unit in Building 163 should be input in separately (i.e., is not included as part of the CATOX unit, whereas the RSE assumed the blower was incorporated within the CATOX based on instructions in SiteWise Version 1.0).

- "Water use" for the GSR evaluation refers to water that is removed for use as a resource. The RSE calculated "water use" based on all extraction. This GSR evaluation only calculates "water use" for the wells where the extracted water is treated at Building 163 (which is then discharged to the POTW), since that represents the water that is removed for use as a resource. The water at the supply wells is used for water supply after treatment, and therefore is not removed for use as a resource as part of the "groundwater remedy". Also, updated extraction rates from 2011 are utilized for the "water use" calculations.

- Similar to water use above, the extraction pumps (i.e. electrical usage) on wells used for water supply were not included in the footprint analysis, because the energy used for this extraction theoretically replaces energy that would be used to provide water from a public utility.

2.2.1 <u>Overview of Baseline Scenario (Per Year)</u>

The groundwater extraction and treatment systems as currently operated serve as a baseline in this GSR evaluation (per year), and involves the following components:

- 6 pumps, assigned as 17.5 HP each (extraction from supply wells 17 AA, CC, EE, BB, JJ, KK/K). Note that extraction at these wells (electricity and water use) is not included in the footprint analysis because they provide water supply after treatment (i.e., not part of the remedy footprint). Note that wells 17K and 17KK pump one at a time.
- 1 pump, 10 HP (extraction well 17FF)
- 2 pumps, 25 HP each (pump water up air stripper (1) and transport treated water from Bldg 163 to POTW, each place has 2 pumps but only one pump at each place is operated at a time)
- 7 pumps, 15 HP each (transfer pumps on 5 individual air strippers (AA/CC, EE, BB, JJ, KK/K), extraction on 2 wells (17S and 17R))
- 4 blowers, 10 HP each (blowers on individual air strippers on supply wells 17 EE, BB, JJ, KK/K)
- 2 blowers, 15 HP each (one on air stripper from supply wells 17 AA/CC, one on Bldg 163 air stripper)
- 1 blower, 25 HP for CATOX in Bldg 163
- Building 163 heater: 400 m (thousand) cubic ft natural/Mo to heat for 5 mo or 2000 MCF natural gas X 1.028 MM (million) BTU/MCF = 2056 MMBtu for one year.
- Catalytic oxidizer with natural gas usage per year of 900 m(thousand)CF/mo
- Water usage (water extracted from the aquifer removed for other use as a resource) – using 2011 rates at wells treated at Building 163 (other wells are used for water supply after treatment and therefore are not counted here), assigned as 105 gpm + 70 gpm + 100 gpm = 275 gpm.

Input to the SiteWise tool and other supporting calculations are described in Appendix B.

2.2.2 Summary of Quantitative Footprint Results, Baseline Scenario

Table 2-2 summarizes the quantitative footprint results for the current system, per year. Input to the SiteWise tool and other supporting calculations are described in Appendix B. The SiteWise files utilized for this portion of the analysis are supplied electronically (SiteWise directory "RA_Baseline_NoFR_1").

Table 2-2 divides total energy use and global warming potential into "direct" and "indirect" use and emissions. The following definitions are utilized for "direct" versus "indirect" energy use and global warming potential:

- Direct Scope 1: From sources that are owned or controlled by the reporting entity.
- Indirect Scope 2: Due to activities of the reporting entity, but occur at sources owned or controlled by another entity, from consumption of purchased electricity, heat or steam.
- Indirect Scope 3: Due to activities of the reporting entity, but occur at sources owned or controlled by another entity, other than Scope 2 (such as the extraction and production of purchased materials and fuels, transport-related activities in vehicles not owned or controlled by the reporting entity, outsourced activities, waste disposal, etc.

Table 2-2
Summary of Quantitative Footprint for Current P&T Systems (Baseline)

GSR Parameter	Unit	Value (per year)
Environmental		
Energy – Total	MMBtu	30,383
Energy – Direct Scope 1	MMBtu	15,758
Energy – Indirect Scope 2	MMBtu	11,766
Energy – Indirect Scope 3	MMBtu	2,859
% of Energy from Renewable Resources	%	Negligible
Global warming potential – Total	Metric tons CO2e	2,651
Global warming potential – Direct Scope 1	Metric tons CO2e	820
Global warming potential – Indirect Scope 2	Metric tons CO2e	1,595
Global warming potential – Indirect Scope 3	Metric tons CO2e	235
Criteria air pollutant emissions	Metric tons (NOx+SOx+PM)	24
Hazardous air pollutant emissions	Lbs	0
Potable water use	1,000s of gallons	145,406
Other water use	1,000s of gallons	0
Refined materials use	Lbs	Not quantified
% of refined materials from recycled material	%	None
Unrefined materials use	Ton	None identified
% of unrefined materials from recycled material	%	N/A
Non-hazardous waste generation	Ton	Not quantified
Hazardous waste generation	Ton	None
% of potential waste that is recycled or re-used	%	0
Land transferred or made available for beneficial use	Acres	0
Existing ecosystem destruction	Acres	Not quantified
Time frame for land re-use	Years	Not determined
Flexibility and breadth of options for re-use	see below	Not determined
Economic		
Life-cycle Cost, Discounted	$	N/A**
Life-cycle Cost, Undiscounted	$	824,000/yr**
Up-front Cost	$	N/A**
Societal		
Predicted number of injuries or fatalities for On-Site Worker	Number of injuries or fatalities	0
Predicted number of injuries or fatalities associated with transportation	Number of injuries or fatalities	0
One-Way Heavy Vehicle Trips through Res. Area	Trips	None

**Scale for flexibility and breadth of re-use options (greater GSR value with lower number, indicating more breadth and flexibility for potential re-use)*

1 - Unlimited re-use options
2 - Limited re-use options
3 - Only one re-use option

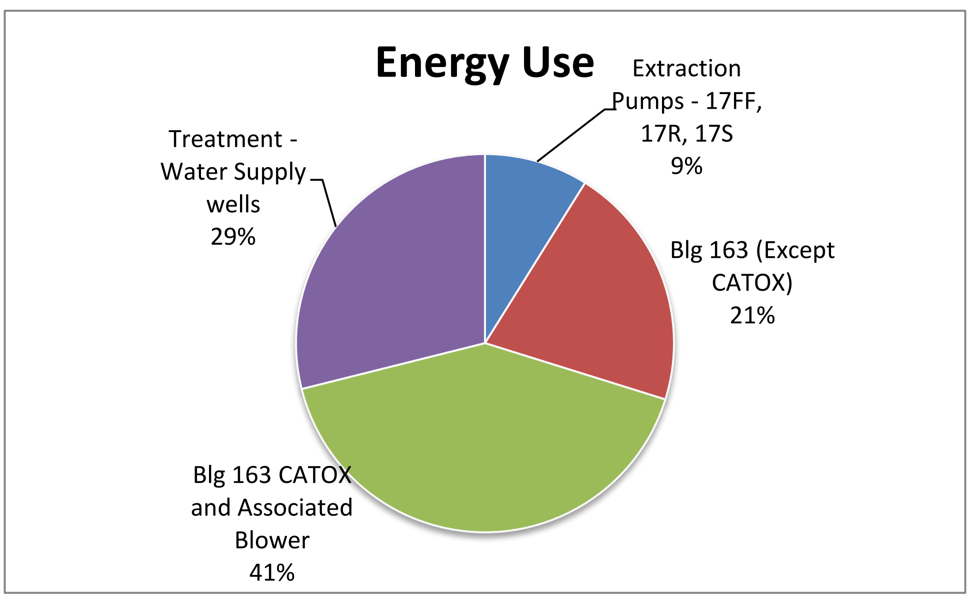
***Costs for this remedy are difficult to assess because the much of the work is being performed under a performance-based contract. Consistent with the previous RSE, this GSR evaluation is done on a per year basis and not on a life-cycle basis. Therefore, there is no up-front cost and no discounted cost for the life-cycle. The annual cost estimate of $824,000 per year that was provided to the RSE team is just for operation of the Building 163 treatment system, and does not include the costs for treatment of the water supply wells or any of the in-situ remedies.*

SiteWise reports total energy use and total global warming potential, but does not sum the "direct" and "indirect" components. The user needs to track the distinction between "direct" and "indirect" components separately, based on information contained within the SiteWise spreadsheets. The separation of the total energy and global warming potential is documented in Appendix B, which describes SiteWise input and related calculations.

2.2.3 Key Findings from Quantitative Footprint Analysis, Baseline Scenario

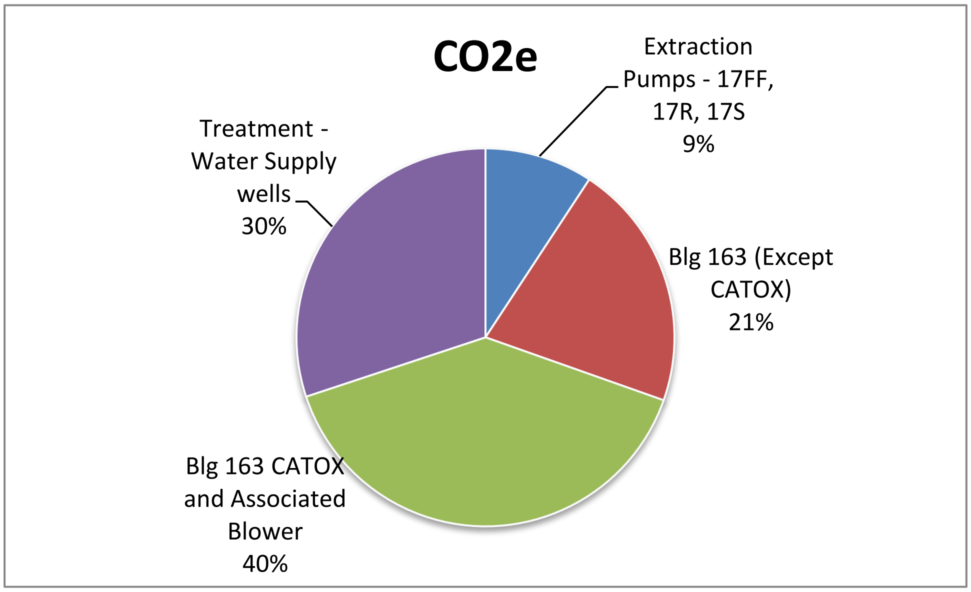
Observations and finding based on the quantitative footprinting results from SiteWise include the following:

- The primary contributors to total energy use for the current P&T systems are illustrated on the graphic below and are summarized as follows:
    - The CATOX unit and associated blower, used for treatment of air after the Building 163 air stripper, use 41.3% of the total energy (12,544 MMBtu/yr). Most of that (~85%) is for natural gas to run the CATOX, and the remainder (~15%) is for the blower electricity.
    - The air strippers and associated transfer pumps for the 7 water supply wells use 28.9% of the total energy (8,781 MMBtu/yr). Most of that (~58%) is for the 5 transfer pumps between the air stripper and the IWTP. The remainder (~42%) is for the 5 air stripper blowers.
    - The rest of the treatment equipment in Building 163 other than the CATOX equipment (i.e., blowers, transfer pumps, and natural gas for building heat) use 20.9% of the total energy (6,356 MMBtu/yr). Most of that (~53%) is for the transfer pumps within Building 163, while the rest is for natural gas used to heat the building (31%) and the air stripper blower (~16%).
    - The extraction pumps for the wells treated at Building 163 (wells 17FF, 17R, and 17S) use 8.9% of the total energy (2,702 MMBtu/yr).



- Approximately 52% of the energy use is “Direct Scope 1”, split between on-site use of electricity (approximately 37%) and on-site combustion of natural gas (approximately 63%). Approximately 39% of the energy use is “Direct Scope 2”, associated with off-site energy used to produce the electricity used on-site. Approximately 9% of the energy use is “Direct Scope 3”, associated with off-site energy used to produce the natural gas used on-site.

- The contributors to GHG emissions (measured in CO2e) are distributed in a similar manner as the energy use, as illustrated below:



- Approximately 60% of the GHG emissions are “Indirect Scope 2”, associated with the off-site generation of electricity used on-site. Approximately 31% is “Direct Scope 1” associated with combustion of natural gas on-site, and approximately 9% is “Indirect Scope 3” associated with off-site production of the natural gas used on-site.

- Most of the NOx emissions (~71%) are associated with the burning of the natural gas associated with the CATOX in Building 163, and ~13% is associated with natural gas used for heating of Building 163. Most of the remainder is associated with extraction and transfer pumps, with a minor amount associated with blowers.

- Most of the SOx emissions (~64%) are associated with extraction and transfer pumps, and the remainder (~36%) is associated with blowers.

- Most of the PM10 emissions (~86%) are associated with the burning of the natural gas associated with the CATOX in Building 163, and the remainder (~14%) is associated with natural gas used for heating of Building 163.

- The total number of injuries/fatalities calculated by SiteWise is zero due to the fact that no transportation to and from the site or construction activities were included in this analysis.

- The percentage of energy from renewable sources is negligible. No on-site renewable energy generation was noted, and eGRID says that for this region of the country only 0.76% of the electricity is from renewable sources. Since not all of the energy use on this site is from electricity, the percentage would be even smaller.

- With respect to materials, the RSE identified use of air stripper media, CATOX calibration gases, and maintenance parts and supplies for pumps, pipes, etc., but quantities were not identified.

- With respect to waste, the RSE identified that plastic rings from the Building 163 stripper go to a landfill, as does iron oxide sludge from the bottom of that stripper. These wastes are mixed with other wastes from the Installation prior to disposal. These wastes were not quantified in the RSE.

- Water usage (water extracted from the aquifer that no longer is available for use as a resource) is primarily extracted groundwater at the site of 275 gpm, or 144,540,000 gallons in a year. This represents the extraction at wells 17FF, 17R and 17S that is treated at Building 163 and subsequently discharged to the POTW. The water extracted from the supply wells is used for water supply after treatment, and therefore is not counted because no water resources are depleted by those extraction wells. A relatively small additional amount of water (1,274,294 gallons per year, or approximately 2.4 gpm) is consumed off-site for the generation of electricity for the P&T operations.

2.3 QUANTITATIVE FOOTPRINT ANALYSIS FOR ALTERNATIVE 1 - ELIMINATE CATOX AT BUILDING 163

2.3.1 Overview of Alternative 1

The RSE indicated that no information was identified stating that treatment of emissions from the Building 163 air stripper is required. This CATOX unit is not mentioned in the air permit, and no requirement for it was identified in the ROD, RD/RAWP, or any other site report. The RSE indicated that the Building 163 air stripper has influent VOC concentrations of approximately 350 ug/l (based on concentrations of TCE, 1,2-DCE and VC reported in Table 4-8 of the IRACR) and a flow rate of approximately 340 gpm (at the time of the RSE, lower flow rate in 2011). This translates to an influent VOC mass of approximately 0.26 tons/year (i.e., without treatment via CATOX). This is a small fraction (approximately 1%) of the overall site emissions (stated to range between 22.7 and 38.3 tons/yr in the air permit). Furthermore, to operate this CATOX requires a 25 HP blower and the use of approximately 900 mcf/month of natural gas, which negatively impacts the environment.

System modifications for this alternative include:

- Eliminate the natural gas usage for the CATOX in Building 163

- Eliminate the blower associated with the CATOX in Building 163

There should be no significant cost to implement this change and potential cost savings of approximately $76,000/yr include the following:

- Annual savings of approximately $54,000 for natural gas
    - 900 mcf/month * 12 months/yr * ~$5/mcf = ~ $54,000/yr

- Annual savings of approximately $11,600 for elimination of the 25 HP blower assuming 0.85 load and 0.85 efficiency, a conversion factor of 0.746 kW/HP, and an estimated electricity rate of $0.07/kWh
    - 25 HP * 0.85/0.85 * 0.746 * 24hrs/day * 365 days/yr * $0.07/kWh = ~$11,400/yr
- Annual savings of approximately $10,300 per year for the CATOX project management contract

Input to the SiteWise tool and other supporting calculations are described in Appendix C1.

2.3.2 Summary of Quantitative Footprint Results for Alternative 1 versus Baseline

Table 2-3 compares key quantitative footprint results for this proposed alternative versus the current P&T systems that serve as the baseline, per year. Input to the SiteWise tool and other supporting calculations are described in Appendix C1. The SiteWise files utilized for this portion of the analysis are supplied electronically ("RA_Alternative1_NoFR_1").

Table 2-3
Summary of Key Quantitative Footprint for Alternative 1 versus Baseline
(Eliminate CATOX at Building 163)

GSR Parameter	Unit	Baseline (per year)	Alternative 1 (per year)
Environmental			
Energy – Total	MMBtu	30,383	17,839
Energy – Direct Scope 1	MMBtu	15,758	6,766
Energy – Indirect Scope 2	MMBtu	11,766	10,635
Energy – Indirect Scope 3	MMBtu	2,859	438
% of Energy from Renewable Resources	%	Negligible	Negligible
Global warming potential – Total	Metric tons CO2e	2,651	1,604
Global warming potential – Direct Scope 1	Metric tons CO2e	820	126
Global warming potential – Indirect Scope 2	Metric tons CO2e	1,595	1,442
Global warming potential – Indirect Scope 3	Metric tons CO2e	235	36
Criteria air pollutant emissions	Metric tons (NOx+SOx+PM)	24	10
Potable water use	1,000s of gallons	145,406	145,323
Up-Front Cost Change (negative for savings)	$		$0
Annual Cost Change (negative for savings)	$/yr		-$ 76,000

2.3.3 Primary Footprints That Would Improve for Alternative 1

The following key footprints would improve in this alternative versus the baseline:

- Total energy use would decline by approximately 12,544 MMBtu per year (41%) primarily due to reduction of the natural gas usage for the CATOX

- GHG emissions would decline by approximately 1,047 metric tons of CO_2e per year (39%) primarily due to reduction of the natural gas usage for the CATOX

- Criteria air pollutant emissions would decline by approximately 14 metric tons per year (58%) primarily due to reduction of the natural gas usage for the CATOX

- Annual cost would decrease by approximately $76,000 per year

With respect to materials, this alternative would eliminate the use of CATOX calibration gases (amount not quantified).

2.3.4 Primary Footprints That Would Worsen for Alternative 1

There would be a very slight increase in hazardous air pollutants since the stripper air effluent would not be treated.

2.4 QUANTITATIVE FOOTPRINT ANALYSIS FOR ALTERNATIVE 2 - ELIMINATE INDIVIDUAL WATER SUPPLY WELL STRIPPERS

2.4.1 Overview of Alternative 2

There are currently seven water supply wells that are treated by five air strippers, with subsequent discharge to the central aerator at the IWTP. The RSE suggested that efficiencies can be gained by eliminating these five strippers and associated transfer pumps, and replacing them with one centralized unit at the aerator where they currently discharge. This could be in the form of an upgrade to the current aerator, or could be in the form of tray stripper placed prior to the aerator. Consolidating treatment in this manner would also reduce fouling in pipelines following the current strippers.

The following motors would be eliminated:

- Combined stripper for 17AA and 17CC- 15 HP blower and 15 HP transfer pump
- Stripper for 17BB - 10 HP blower and 15 HP transfer pump
- Stripper for 17EE - 10 HP blower and 15 HP transfer pump
- Stripper for 17JJ - 10 HP blower and 15 HP transfer pump
- Combined stripper for 17K and 17KK - 10 HP blower and 15 HP transfer pump

This represents 130 HP eliminated. The RSE assumed that upgrades at the IWTP will require the addition of approximately a 30 HP blower (this cannot be refined at this time due to lack of information for flow rates and concentrations). In net, approximately 100 HP would be saved. This translates to an annual savings of approximately $46,000 for elimination of a 100 HP blower assuming 0.85 load and 0.85 efficiency, a conversion factor of 0.746 kW/HP, and an estimated electricity rate of $0.07/kWh.

100 HP * 0.85/0.85 * 0.746 * 24hrs/day * 365 days/yr * $0.07/kWh = ~$46,000/yr

There will likely be some additional savings in labor associated with maintaining these strippers, but that has not been quantified.

There will presumably be some up-front costs (including design) to implement this recommendation. The RSE estimated that a centralized solution may cost on the order of $200,000 up-front to design and implement. Assuming a $200,000 up-front cost and savings of approximately $46,000 per year, the payback period would be less than 5 years.

Input to the SiteWise tool and other supporting calculations are described in Appendix C2.

2.4.2 Summary of Quantitative Footprint Results for Alternative 2 versus Baseline

Table 2-4 compares key quantitative footprint results for this proposed alternative versus the current P&T systems that serve as the baseline, per year. Input to the SiteWise tool and other supporting calculations are described in Appendix C2. The SiteWise files utilized for this portion of the analysis are supplied electronically ("RA_Alternative2_NoFR_1").

Table 2-4
Summary of Quantitative Footprint for Alternative 2 versus Baseline
(Eliminate Individual Water Supply Well Strippers)

GSR Parameter	Unit	Baseline (per year)	Alternative 2 (per year)
Environmental			
Energy – Total	MMBtu	30,383	23,628
Energy – Direct Scope 1	MMBtu	15,758	13,529
Energy – Indirect Scope 2	MMBtu	11,766	7,241
Energy – Indirect Scope 3	MMBtu	2,859	2,859
% of Energy from Renewable Resources	%	Negligible	Negligible
Global warming potential – Total	Metric tons CO2e	2,651	2,038
Global warming potential – Direct Scope 1	Metric tons CO2e	820	820
Global warming potential – Indirect Scope 2	Metric tons CO2e	1,595	982
Global warming potential – Indirect Scope 3	Metric tons CO2e	235	235
Criteria air pollutant emissions	Metric tons (NOx+SOx+PM)	24	20
Potable water use	1,000s of gallons	145,406	145,073
Up-Front Cost Change (negative for savings)	$		$200,000
Annual Cost Change (negative for savings)	$/yr		-$46,000

2.4.3 Primary Footprints That Would Improve for Alternative 2

The following key footprints would improve in this alternative versus the baseline:

- Total energy use would decline by approximately 6,755 MMBtu per year (22%) due to reduction of electrical usage
- GHG emissions would decline by approximately 613 metric tons of CO2e per year (23%) due to reduction of electrical usage

- Criteria air pollutant emissions would decline by approximately 4 metric tons per year (17%) due to reduction of electrical usage

- Annual cost would decrease by approximately $46,000 per year

With respect to materials, this alternative would likely eliminate the air stripper media required for the supply well strippers (not quantified), and with respect to waste, this alternative would likely eliminate the iron oxide sludge for the supply well strippers (not quantified). However, some additional materials and waste may be associated with enhanced operation of the aerator at the IWTP.

2.4.4 Primary Footprints That Would Worsen for Alternative 2

The only primary footprint that would worsen would be up-front costs of approximately $200,000 that might be required. However, given the reduction in annual costs of approximately $46,000 per year, the payback period would be less than five years.

2.5 QUANTITATIVE FOOTPRINT ANALYSIS FOR ALTERNATIVE 3 - DIRECT DISCHARGE TO POTW FROM 17S, 17FF, AND 17R

2.5.1 Overview of Alternative 3

The RSE suggested that the discharge standards to the POTW needed to be clarified, but suspected that the influent concentrations at the Building 163 air stripper are below discharge standards. If so, it may be possible to reach agreement with the POTW for them to accept discharged water without air stripper treatment. The following benefits would be realized:

- Reduced electricity by eliminating the 15 HP Blower for the air stripper

- Reduced labor for vacuuming/cleaning the stripper material and disposing of the iron sludge material

- Eliminate at least one of the 25 HP water transfer pumps

- Eliminate the CATOX and associated blower

- Reduced operator labor and maintenance in general

No significant up-front costs would be expected, and total savings of approximately $131,500 per year could result from this change, as follows:

- Approximately $76,000 per year for elimination of the CATOX and associated blower (see Alternative 1)

- The savings for the 40 HP of electricity would lead to annual savings of approximately $18,000 assuming 0.85 load and 0.85 efficiency, a conversion factor of 0.746 kW/HP, and an estimated electricity rate of $0.07/kWh.

$$40 \text{ HP} * 0.8/0.75 * 0.746 * 24\text{hrs/day} * 365 \text{ days/yr} * 0.95 * \$0.07/\text{kWh} = \sim\$18,000/\text{yr}$$

- Air stripper media and disposal cost of approximately $17,500 would be eliminated.

- Assuming labor is reduced by 300 hrs at an approximate rate of $60/hr would save an additional $18,000 per year.

- At least $2,000 of savings in materials/supplies might be expected.

Input to the SiteWise tool and other supporting calculations are described in Appendix C3.

2.5.2 Summary of Quantitative Footprint Results for Alternative 3 versus Baseline

Table 2-5 compares key quantitative footprint results for this proposed alternative versus the current P&T systems that serve as the baseline, per year. Input to the SiteWise tool and other supporting calculations are described in Appendix C3. The SiteWise files utilized for this portion of the analysis are supplied electronically ("RA_Alternative3_NoFR_1").

Table 2-5
Summary of Quantitative Footprint for Alternative 3 versus Baseline
(Direct Discharge to POTW from 17S, 17FF, and 17R)

GSR Parameter	Unit	Baseline (per year)	Alternative 3 (per year)
Environmental			
Energy – Total	MMBtu	30,383	13,171
Energy – Direct Scope 1	MMBtu	15,758	4,346
Energy – Indirect Scope 2	MMBtu	11,766	8,825
Energy – Indirect Scope 3	MMBtu	2,859	0
% of Energy from Renewable Resources	%	Negligible	Negligible
Global warming potential – Total	Metric tons CO2e	2,651	1,196
Global warming potential – Direct Scope 1	Metric tons CO2e	820	0
Global warming potential – Indirect Scope 2	Metric tons CO2e	1,595	1,196
Global warming potential – Indirect Scope 3	Metric tons CO2e	235	0
Criteria air pollutant emissions	Metric tons (NOx+SOx+PM)	24	6
Potable water use	1,000s of gallons	145,406	145,190
Up-Front Cost Change (negative for savings)	$		$0
Annual Cost Change (negative for savings)	$/yr		-$131,500

2.5.3 Primary Footprints That Would Improve for Alternative 3

The following key footprints would improve in this alternative versus the baseline:

- Total energy use would decline by approximately 17,212 MMBtu per year (57%) due to reduction of electrical usage and elimination of natural gas usage.

- GHG emissions would decline by approximately 1,455 metric tons of CO2e per year (55%) due to reduction of electrical usage and elimination of natural gas usage.

- Criteria air pollutant emissions would decline by approximately 18 metric tons per year (75%) due to reduction of electrical usage and elimination of natural gas usage.

- Annual cost would decrease by approximately $131,500 per year

With respect to materials, this alternative would eliminate the use of air stripper media and CATOX calibration gases for Building 163 (not quantified). With respect to waste, this alternative would eliminate the iron oxide sludge from the air stripper media for Building 163 (not quantified).

2.5.4 Primary Footprints That Would Worsen for Alternative 3

None of the quantitative footprints would worsen for this alternative versus the baseline.

2.6 QUANTITATIVE FOOTPRINT ANALYSIS FOR ALTERNATIVE 4 - TREATMENT OF ALL EXTRACTED WATER AT ON-SITE TREATMENT PLANT FOR USE AS WATER SUPPLY, WITH NO PRE-TREATMENT AT BUILDING 163

2.6.1 Overview of Alternative 4

The RSE suggested an engineering study to evaluate the feasibility and cost-benefit of building piping to bring water from the Building 163 area to the IWTP. This alternative involves sending the combined flow from the supply wells and extraction wells 17FF, 17S, and 17R to an upgraded IWTP, thus cutting out treatment at Building 163 and also cutting out air strippers currently used on individual supply wells. It also cuts out discharge to the POTW, which is currently estimated to cost $335,000 per year. This alternative assumes a 30 HP blower is added to the current plant for additional treatment capacity, and assumes that the water currently pumped from wells 17FF, 17R and 17S would be used for water supply after treatment, reducing the amount of extraction required at the other water supply wells by 275 gpm. The potential savings annual savings could be on the order of $600,000 per year for the Building 163 system, plus savings of approximately $46,000 per year for eliminating the supply well strippers and transfer pumps (see Alternative 2). There may be added savings from eliminating one or more current supply well extraction pumps (not quantified). The payback period would depend on the magnitude of the total up-front costs versus the annual cost savings. There would be up-front costs for upgrading the IWTP (estimated at $200,000 in Alternative 2) and an up-front cost for piping from Building 163 to the IWTP which could be substantial. A detailed estimate for piping from Building 163 area to bring water to the IWTP has not been performed, a rough cost is estimated (5,000 ft * $55/ft = $275,000 + $75,000 design/misc = $350,000). Using a very preliminary estimate for up-front costs of approximately $550,000 for IWTP improvements plus piping, the payback period might be less than 1 year. Even if the piping cost was much higher, payback would very likely occur within 2-3 years.

2.6.2 Summary of Quantitative Footprint Results for Alternative 4 versus Baseline

Table 2-6 compares key quantitative footprint results for this proposed alternative versus the current P&T systems that serve as the baseline, per year. Input to the SiteWise tool and other supporting calculations are described in Appendix C4. The SiteWise files utilized for this portion of the analysis are supplied electronically (“RA_Alternative4_NoFR_1”).

Table 2-6
Summary of Quantitative Footprint for Alternative 4 versus Baseline
(Treatment of All Water at On-Site Treatment Plant for use
as Water Supply, with no Pre-Treatment at Building 163)

GSR Parameter	Unit	Baseline (per year)	Alternative 4 (per year)
Environmental			
Energy – Total	MMBtu	30,383	3,715
Energy – Direct Scope 1	MMBtu	15,758	1,226
Energy – Indirect Scope 2	MMBtu	11,766	2,489
Energy – Indirect Scope 3	MMBtu	2,859	0
% of Energy from Renewable Resources	%	Negligible	Negligible
Global warming potential – Total	Metric tons CO2e	2,651	337
Global warming potential – Direct Scope 1	Metric tons CO2e	820	0
Global warming potential – Indirect Scope 2	Metric tons CO2e	1,595	337
Global warming potential – Indirect Scope 3	Metric tons CO2e	235	0
Criteria air pollutant emissions	Metric tons (NOx+SOx+PM)	24	2
Potable water use	1,000s of gallons	145,406	183
Up-Front Cost Change (negative for savings)	$		$550,000*
Annual Cost Change (negative for savings)	$/yr		-$646,000

**Up-Front cost of $200,000 estimated in Alternative 2 for upgrade of the IWTP. Additional up-front cost for piping water from Building 163 to the IWTP preliminarily estimated at $350,000 (rough estimate).*

2.6.3 <u>Primary Footprints That Would Improve for Alternative 4</u>

The following key footprints would improve in this alternative versus the baseline:

- Total energy use would decline by approximately 26,668 MMBtu per year (88%) due to reduction of electrical usage and elimination of natural gas usage.

- GHG emissions would decline by approximately 2,314 metric tons of CO2e per year (87%) due to reduction of electrical usage and elimination of natural gas usage.

- Criteria air pollutant emissions would decline by approximately 22 metric tons per year (92%) due to reduction of electrical usage and elimination of natural gas usage.

- The amount of water that is extracted and lost as a resource is eliminated since all water extracted would be used for water supply in this alternative. Thus, this preserves 275 gpm of water as a resource, or 144,540,000 gallons over the course of a year. There still remains a slight use of water consumed off-site for generation of electricity used for the P&T remedy.

- Annual cost would decrease by approximately $646,000 per year.

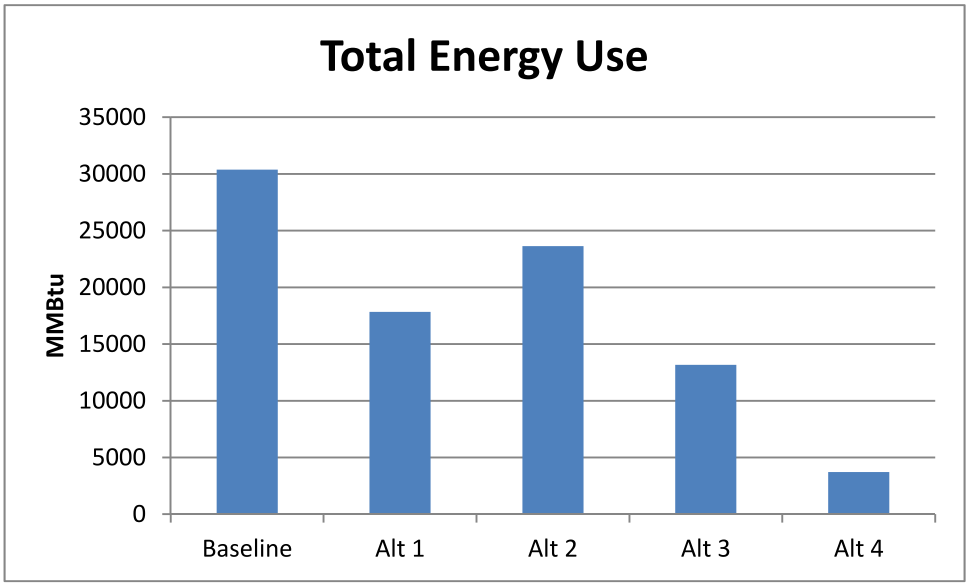
With respect to materials, this alternative would eliminate the use of air stripper media and CATOX calibration gases for Building 163 and air stripper media for the supply well strippers (not quantified). With respect to waste, this alternative would eliminate the iron oxide sludge from the air stripper media for Building 163 and for the supply well strippers (not quantified). However, some additional materials and waste may be associated with enhanced operation of the aerator at the IWTP.

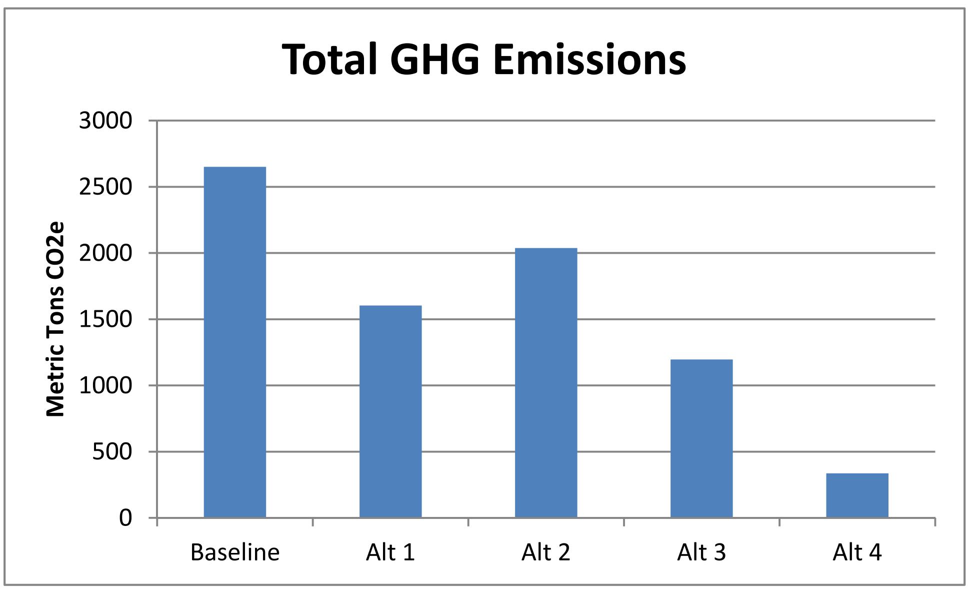
2.6.4 Primary Footprints That Would Worsen for Alternative 4

There would be up-front costs for upgrading the IWTP (estimated at $200,000 in Alternative 2) and an up-front cost for piping from Building 163 to the IWTP which could be substantial (preliminary rough estimate of $350,000). The payback period would depend on the magnitude of the total up-front costs versus the annual cost savings. Using a very preliminary estimate for up-front costs of approximately $550,000 for IWTP improvements plus piping, the payback period might be less than 1 year. Even if the piping cost was much higher, payback would very likely occur within 2-3 years.

2.7 COMPARISON OF ENERGY USE AND CO2E BY ALTERNATIVE

The charts below compare energy use and CO2e by alternative.





Note that Alternative 3 adds to elements of Alternative 1, and Alternative 4 adds to elements of Alternative 2.

2.8 CASE STUDY FOOTPRINT ANALYSES OF MOLASSES, MOLWHEY, AND VEGETABLE OIL

2.8.1 Overview of ERD Substrate Case Studies

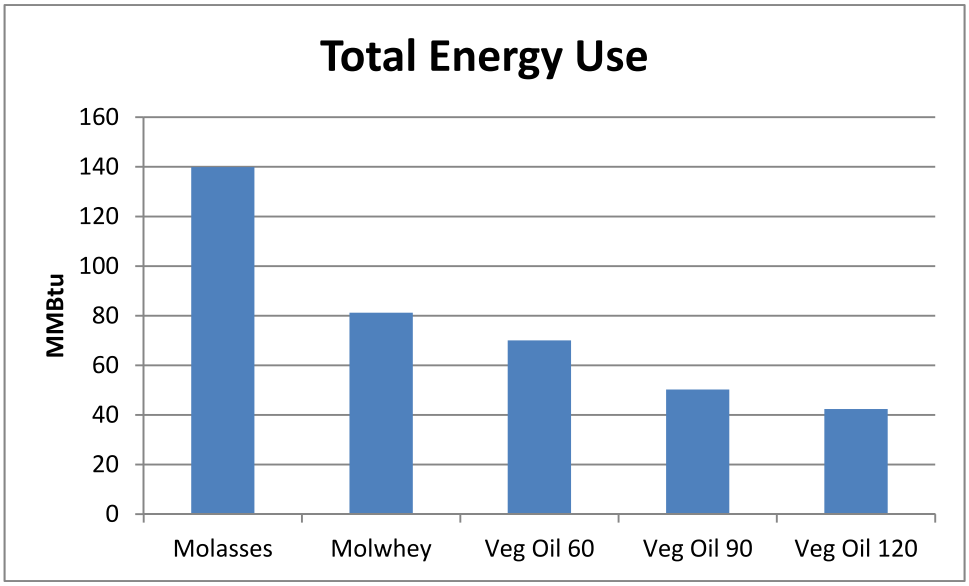
Groundwater treatment at LCAAP also includes in-situ treatment, which consists of enhanced reductive dechlorination (ERD) via injection of organic carbon substrate. A detailed description of the in-situ treatment being conducted at LCAAP is included in Section 1.2.2.3 of this report. The in-situ treatment at this site involves multiple injection lines at various locations, with multiple injections over time at the injection lines. The injection substrate (material and percent solution) as well as the frequency of injections differ between locations and have changed over time. Both molasses and a molasses/cheese whey mixture ("molwhey") have been used at LCAAP. In addition, the recent RSE report for LCAAP included a recommendation to "perform cost-benefit analysis for switch to emulsified vegetable oil for ERD carbon substrate".

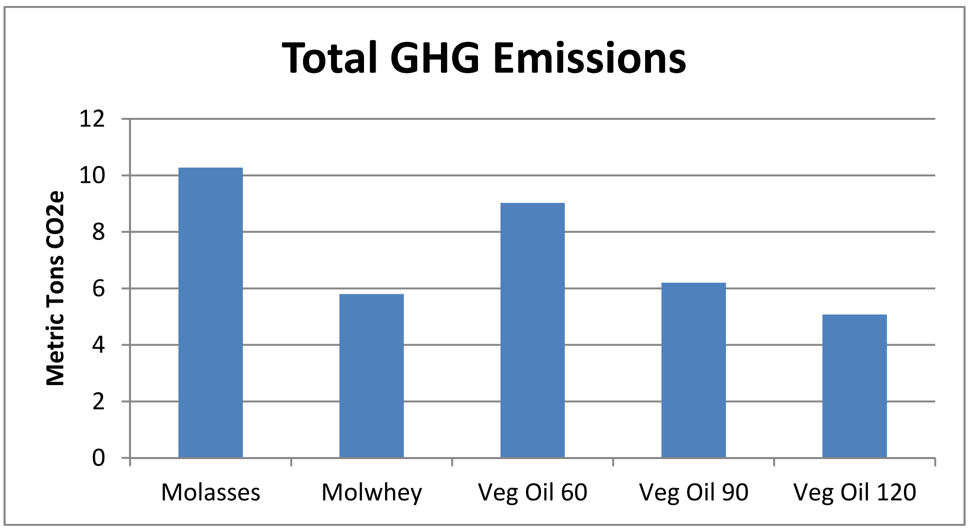
Given the diverse set of substrate types and concentrations that have historically been applied at LCAAP, it would be very difficult and confusing to attempt to quantitatively footprint the historical ERD injections. Therefore, this GSR evaluation includes a more "generic" set of case studies that compare quantitative footprints for three different substrates: molasses, molwhey, and vegetable oil. In addition to illustrating the type of information that would be needed for site-specific footprint analysis of an in-situ treatment system, the purpose of these case studies is to demonstrate for the Project Team at LCAAP the potential differences between the footprints for the various substrates being considered (based on the assumptions made for the analysis).

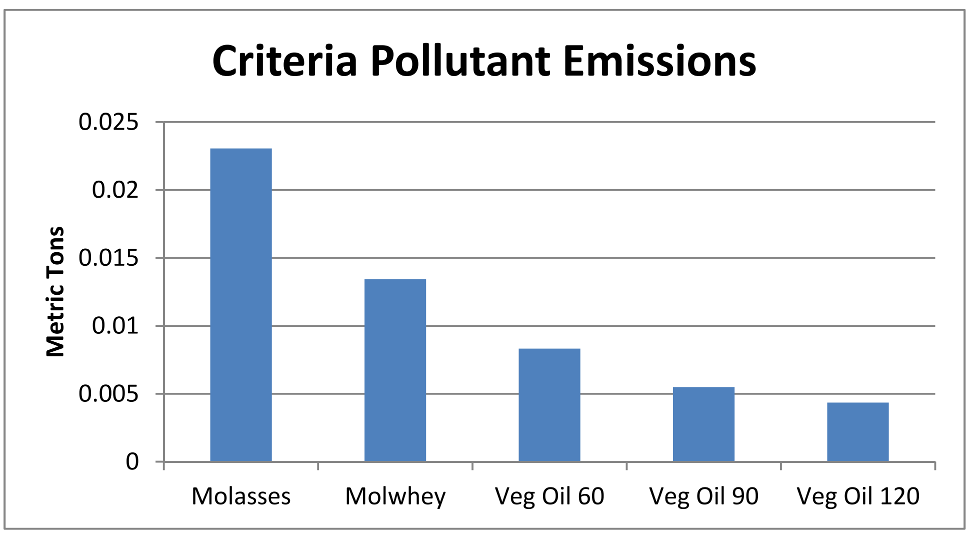
The RSE report indicates that the half-lives for molasses and molwhey at this site were found to be approximately 20 days and 35 days, respectively, and these half-lives were assumed when calculating the SiteWise inputs for these substrates. Pilot testing would need to be conducted to determine the half-life for vegetable oil injections at LCAAP. For this GSR evaluation footprints were calculated for vegetable oil injections using half-lives of 60 days, 90 days, and 120 days in order to determine if there is a half-life "threshold" above which vegetable oil injections would be preferable (with respect to GSR considerations) to molasses or molwhey. For each substrate alternative, SiteWise inputs are calculated based on the assumption that the same amount and concentration of substrate as with molasses will be used per injection event, but that injection events will occur less frequently based on the extended half-life. A detailed description of the assumptions and calculations for SiteWise input for all of the ERD case study alternatives can be found in Appendix D of this report. Because SiteWise does not have conversion factors for these specific substrates (i.e., to compute energy use and CO2e emissions given a specific amount of the material), values for conversion factors were manually added to the SiteWise "lookup tables" based on data provided in the *LCA food data base* (www.lcafood.dk) referenced in Appendix D.

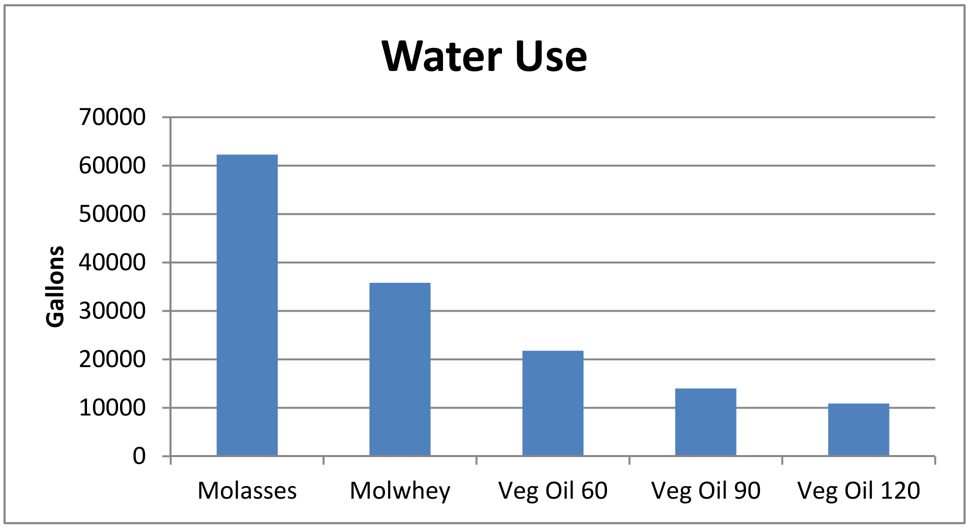
2.8.2 Summary of Key Quantitative Footprint Results for Case Study Alternatives

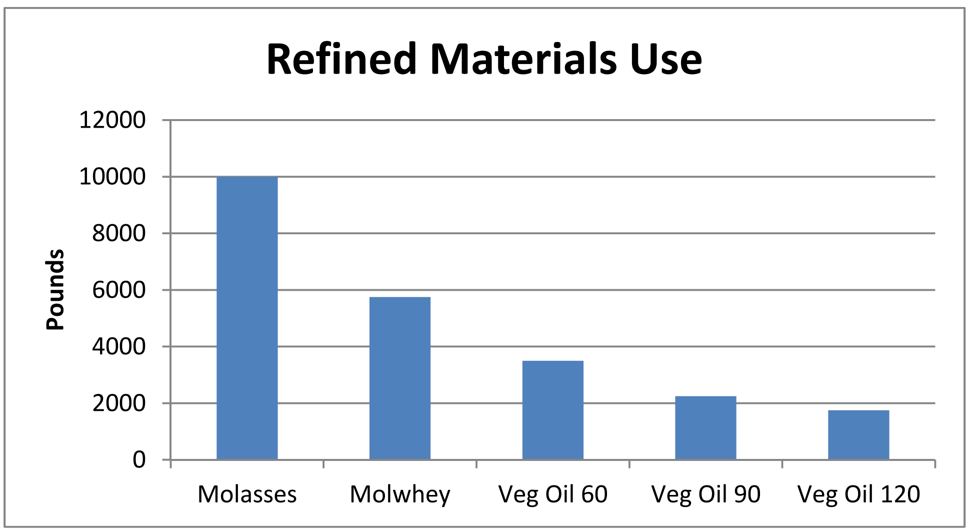
The charts below compare energy use, CO2e, and other key quantitative footprints for the molasses, molwhey, and three vegetable oil scenarios (60, 90,and 120 days half-lives).

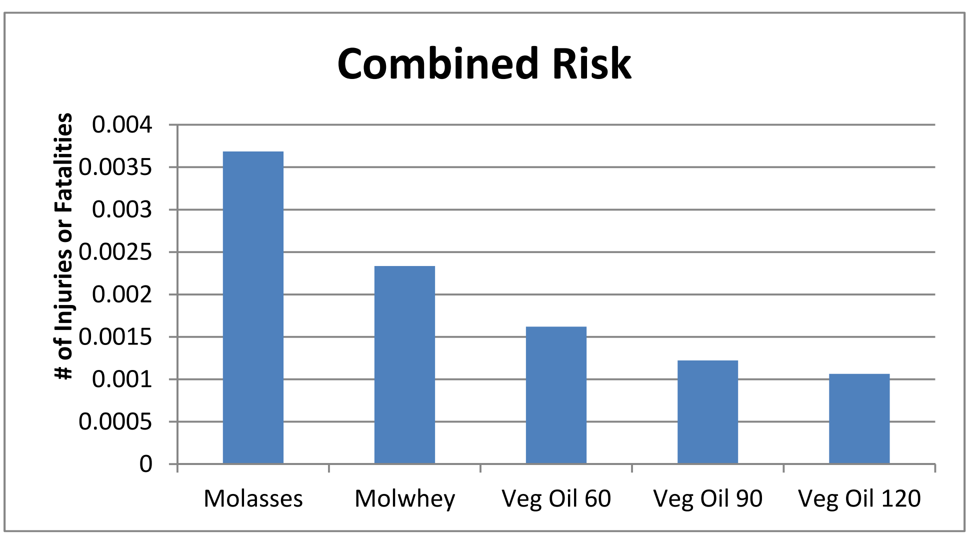

Total Energy Use
MMBtu
0
20
40
60
80
100
120
140
160
Molasses
Molwhey
Veg Oil 60
Veg Oil 90
Veg Oil 120


Total GHG Emissions
Metric Tons CO2e
0
2
4
6
8
10
12
Molasses
Molwhey
Veg Oil 60
Veg Oil 90
Veg Oil 120


Criteria Pollutant Emissions
Metric Tons
0
0.005
0.01
0.015
0.02
0.025
Molasses
Molwhey
Veg Oil 60
Veg Oil 90
Veg Oil 120


Water Use
Gallons
70000
60000
50000
40000
30000
20000
10000
0
Molasses
Molwhey
Veg Oil 60
Veg Oil 90
Veg Oil 120


Refined Materials Use
Pounds
12000
10000
8000
6000
4000
2000
0
Molasses
Molwhey
Veg Oil 60
Veg Oil 90
Veg Oil 120


Combined Risk
# of Injuries or Fatalities
0.004
0.0035
0.003
0.0025
0.002
0.0015
0.001
0.0005
0
Molasses
Molwhey
Veg Oil 60
Veg Oil 90
Veg Oil 120

The charts above (for key footprint metrics) indicate that molwhey is generally favorable from a GSR perspective versus molasses, and that vegetable oil is generally favorable from a GSR perspective versus molwhey as long as the half-life for the vegetable oil is long enough.

- If the vegetable oil half-life is 60 days, then there is a mixed result because most footprints (energy use, criteria pollutants, water use, materials use, and accident/fatality risk) are lower for the vegetable oil than for the molwhey, but greenhouse gas emissions are higher for the vegetable oil than for the molwhey.

- If the vegetable oil half-life is 90 days, then the footprint reductions (energy use, criteria pollutants, water use, materials use, and accident/fatality risk) are even greater for the vegetable oil, and the greenhouse gas emissions are nearly identical for the vegetable oil versus the molwhey.

- If the vegetable oil half-life is more than 90 days (e.g., 120 days), then all the footprints are lower for the vegetable oil versus the molwhey.

This is a generic evaluation based on assumptions stated in Appendix D, and does not address the cost of each specific substrate. However, these results suggest that pilot testing might be merited to determine if the vegetable oil half-life is greater than 90 days at LCAAP. This analysis assumed 4 injections per year for molasses versus 2.3 injections per year for molwhey (based on the relative half-life compared to molasses). The injection frequencies for vegetable oil were 1.4 injections per year for a half-life of 60 days, 0.9 injections per year for a half-life of 90 days, and 0.7 injections per year for a half-life of 120 days. Many real-world systems using vegetable oil for ERD have injection frequencies on the order of 1-3 years, consistent with the half-lives of 90 days or greater.

2.9 OTHER QUALITATIVE CONSIDERATIONS

The alternatives evaluated above were based on recommendations in the RSE report. Although there are clear benefits that could result from the implementation of one or more of these alternatives (in terms of cost as well as other GSR metrics), there may be constraints to implementing specific alternatives to the current P&T systems. These constraints may be associated with contracting, regulatory issues associated with changes to the remedy, and/or funding limitations for items that require up-front costs. This GSR evaluation provides valuable information regarding potential benefits (e.g., GSR metrics including cost) that may be realized if such constraints can be addressed.

3.0 GSR RECOMMENDATIONS

These are recommendations provided by the GSR Team for the consideration of the Project Team, and potentially other project stakeholders. These are not requirements, and implementation should ultimately be decided by the Project Team based on their concurrence regarding GSR benefits and/or other project-specific constraints.

GSR recommendations are summarized in the form of tracking tables, as follows:

Table Number	**Recommendation**
3-1	3.1 - Eliminate CATOX operation From Building 163
3-2	3.2 - Eliminate water supply strippers and associated transfer pumps (requires upgrades at IWTP aerator)
3-3	3.3 - Evaluate potential for eliminating air stripping completely at building 163 with direct discharge to the POTW*
3-4	3.4 - Evaluate potential for treatment of all water at IWTP for use as Water Supply, with no Pre-Treatment at Building 163**
3-5	3.5 - Evaluate VFDs for pump and blower motors after other recommendations have been implemented (once the final configuration of pumps and motors is established based on other recommendations)
3-6	3.6 - Consider pilot testing for vegetable oil as ERD substrate

**adds to elements of Recommendation 3.1*
***adds to elements of Recommendation 3.2*

The tracking table format allows the implementation status of the recommendation to be updated as the project progresses.

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Table 3-1
Tracking Table for Recommendation 3.1

<table>
<tr><td colspan="2" rowspan="2">Recommendation:

3.1 - Eliminate CATOX operation From Building 163</td><td>Current Date:
1/26/12</td></tr>
<tr><td>Date of Original Recommendation:
1/26/12</td></tr>
<tr><td colspan="3">Basis for Recommendation (Include discussion of cost impacts and value if appropriate):

The RSE indicated that no information was identified stating that treatment of emissions from the Building 163 air stripper is required. This CATOX unit is not mentioned in the air permit, and no requirement for it was identified in the ROD, RD/RAWP, or any other site report. The RSE indicated that the Building 163 air stripper has influent VOC concentrations of approximately 350 ug/l (based on concentrations of TCE, 1,2-DCE and VC reported in Table 4-8 of the IRACR) and a flow rate of approximately 340 gpm (at the time of the RSE, lower flow rate in 2011). This translates to an influent VOC mass of approximately 0.26 tons/year (i.e., without treatment via CATOX). This is a small fraction (approximately 1%) of the overall site emissions (stated to range between 22.7 and 38.3 tons/yr in the air permit). Furthermore, to operate this CATOX requires a 25 HP blower and the use of approximately 900 mcf/month of natural gas, which negatively impacts the environment. There should be no significant cost to implement this change and potential cost savings of approximately $76,000/yr.

• *Total energy use would decline by approximately 12,544 MMBtu per year (32%)*
• *GHG emissions would decline by approximately 1,048 metric tons of CO2e per year (31%)*
• *Criteria air pollutant emissions would decline by approximately 13 metric tons per year (48%)*
• *Would eliminate the use of CATOX calibration gases (amount not quantified).*</td></tr>
<tr><td colspan="3">Resources Conserved:
☐ Hazardous air pollutants ☒ GHG emissions (CO2e) ☒ Energy ☒ Water ☐ Waste
☒ Criteria pollutants ☐ Safety/Community ☒ Materials ☐ Land-use</td></tr>
<tr><td>Qualitative Net Cost Impact Over 5 Years, No Discounting

☐ Cost Increase ☒ Cost Savings
☐ Cost Neutral ☐ N/A</td><td colspan="2">☐ Recommended action otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="3">Attachment(s) to report with footprint assumptions and calculations:

See Section2.3 and Appendix C-1</td></tr>
<tr><td>Implementation Status:

☐ Fully
☐ Partially
☒ Not Yet
☐ Not Planned</td><td colspan="2">Explanation of Status:

Recommended in RSE. Note this recommendation is also incorporated in Recommendation 3.3.</td></tr>
</table>

Table 3-2
Tracking Table for Recommendation 3.2

Recommendation: *3.2 - Eliminate water supply strippers and associated transfer pumps (requires upgrades at IWTP aerator)*	Current Date: 1/26/12 Date of Original Recommendation: 1/26/12

Basis for Recommendation (Include discussion of cost impacts and value if appropriate):

There are currently seven water supply wells that are treated by five air strippers, with subsequent discharge to the central aerator at the IWTP. The RSE suggested that efficiencies can be gained by eliminating these five strippers and associated transfer pumps, and replacing them with one centralized unit at the aerator where they currently discharge. This could be in the form of an upgrade to the current aerator, or could be in the form of tray stripper placed prior to the aerator. Consolidating treatment in this manner would also reduce fouling in pipelines following the current strippers. 130 HP would be eliminated. The RSE assumed that upgrades at the IWTP will require the addition of approximately a 30 HP blower (this cannot be refined at this time due to lack of information for flow rates and concentrations). In net, approximately 100 HP would be saved. This translates to an annual savings of approximately $46,000/yr. There will presumably be some up-front costs (including design) to implement this recommendation. The RSE estimated that a centralized solution may cost on the order of $200,000 up-front to design and implement. Assuming a $200,000 up-front cost and savings of approximately $46,000 per year, the payback period would be less than 5 years.

- *Total energy use would decline by approximately 6,754 MMBtu per year (17%)*
- *GHG emissions would decline by approximately 614 metric tons of CO2e per year (18%)*
- *Criteria air pollutant emissions would decline by approximately 3 metric tons per year (11%)*

Resources Conserved:
☐ Hazardous air pollutants ☒ GHG emissions (CO2e) ☒ Energy ☒ Water ☒ Waste
☒ Criteria pollutants ☐ Safety/Community ☒ Materials ☐ Land-use

Qualitative Net Cost Impact Over 5 Years, No Discounting ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A	☐ Recommended action otherwise required? If checked, required by:

Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☒ $100,001 - $500,000 ☐ > $500,000

Attachment(s) to report with footprint assumptions and calculations:

See Section2.4 and Appendix C-2

Implementation Status: ☐ Fully ☐ Partially ☒ Not Yet ☐ Not Planned	Explanation of Status: *Recommended in RSE. Note that this recommendation is also incorporated into Recommendation 3.4.*

Table 3-3
Tracking Table for Recommendation 3.3

Recommendation:	Current Date: 1/26/12
3.3 - Evaluate potential for eliminating air stripping completely at building 163 with direct discharge to the POTW	Date of Original Recommendation: 1/26/12

Basis for Recommendation (Include discussion of cost impacts and value if appropriate):

The RSE suggested that the discharge standards to the POTW needed to be clarified, but suspected that the influent concentrations at the Building 163 air stripper are below discharge standards. If so, it may be possible to reach agreement with the POTW for them to accept discharged water without air stripper treatment. The following benefits would be realized: Reduced electricity by eliminating the 15 HP Blower for the air stripper; Reduced labor for vacuuming/cleaning the stripper material and disposing of the iron sludge material; Eliminate at least one of the 25 HP water transfer pumps; Eliminate the CATOX and associated blower; Reduced operator labor and maintenance in general. No significant up-front costs would be expected, and total savings of approximately $131,500 per year could result from this change.

- *Total energy use would decline by approximately 17,212 MMBtu per year (45%)*
- *GHG emissions would decline by approximately 1,455 metric tons of CO2e per year (43%)*
- *Criteria air pollutant emissions would decline by approximately 17 metric tons per year (63%)*
- *would eliminate the use of air stripper media and CATOX calibration gases for Building 163 (not quantified), and would eliminate the iron oxide sludge from the air stripper media for Building 163 (not quantified).*

Resources Conserved:
☐ Hazardous air pollutants ☒ GHG emissions (CO2e) ☒ Energy ☒ Water ☒ Waste
☒ Criteria pollutants ☐ Safety/Community ☒ Materials ☐ Land-use

Qualitative Net Cost Impact Over 5 Years, No Discounting	☐ Recommended action otherwise required? If checked, required by:
☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A	

Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Attachment(s) to report with footprint assumptions and calculations:

See Section2.5 and Appendix C-3

Implementation Status:	Explanation of Status:
☐ Fully ☐ Partially ☒ Not Yet ☐ Not Planned	*Recommended in RSE. Includes Recommendation 3.1.*

Table 3-4
Tracking Table for Recommendation 3.4

<table>
<tr><td rowspan="2">Recommendation:

3.4 - Evaluate potential for treatment of all water at IWTP for use as Water Supply, with no Pre-Treatment at Building 163</td><td>Current Date:
1/26/12</td></tr>
<tr><td>Date of Original Recommendation:
1/26/12</td></tr>
<tr><td colspan="2">Basis for Recommendation (Include discussion of cost impacts and value if appropriate):

The RSE suggested an engineering study to evaluate the feasibility and cost-benefit of building piping to bring water from the Building 163 area to the IWTP. This alternative involves sending the combined flow from the supply wells and extraction wells 17FF, 17S, and 17R to an upgraded IWTP, thus cutting out treatment at Building 163 and also cutting out air strippers currently used on individual supply wells. It also cuts out discharge to the POTW, which is currently estimated to cost $335,000 per year. This alternative assumes a 30 HP blower is added to the current plant for additional treatment capacity, and assumes that the water currently pumped from wells 17FF, 17R and 17S would be used for water supply after treatment, reducing the amount of extraction required at the other water supply wells by 275 gpm. There may be added savings from eliminating one or more current supply well extraction pumps (not quantified). The payback period would depend on the magnitude of the total up-front costs versus the annual cost savings. Using a very preliminary estimate for up-front costs of approximately $550,000 for IWTP improvements plus piping, the payback period might be less than 1 year. Even if the piping cost was much higher, payback would very likely occur within 2-3 years.

• *Total energy use would decline by approximately 23,966 MMBtu per year (62%)*
• *GHG emissions would decline by approximately 2,069 metric tons of CO2e per year (61%)*
• *Criteria air pollutant emissions would decline by approximately 20 metric tons per year (74%)*
• *Preserves 275 gpm of water as a resource, or 144,540,000 gallons over the course of a year*</td></tr>
<tr><td colspan="2">Resources Conserved:
☐ Hazardous air pollutants ☒ GHG emissions (CO2e) ☒ Energy ☒ Water ☒ Waste
☒ Criteria pollutants ☐ Safety/Community ☒ Materials ☐ Land-use</td></tr>
<tr><td>Qualitative Net Cost Impact Over 5 Years, No Discounting

☐ Cost Increase ☒ Cost Savings
☐ Cost Neutral ☐ N/A</td><td>☐ Recommended action otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="2">Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☒ > $500,000</td></tr>
<tr><td colspan="2">Attachment(s) to report with footprint assumptions and calculations:
See Section2.6 and Appendix C-4</td></tr>
<tr><td>Implementation Status:

☐ Fully
☐ Partially
☒ Not Yet
☐ Not Planned</td><td>Explanation of Status:

Recommended in RSE. Includes Recommendation 3.2.</td></tr>
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Table 3-5
Tracking Table for Recommendation 3.5

<table>
<tr><td colspan="3">Recommendation:

3.5 - Evaluate VFDs for pump and blower motors after other recommendations have been implemented (once the final configuration of pumps and motors is established based on other recommendations)</td><td>Current Date:
1/26/12

Date of Original Recommendation:
1/26/12</td></tr>
<tr><td colspan="4">Basis for Recommendation (Include discussion of cost impacts and value if appropriate):

Some of the motors currently utilized for pumps and/or blowers could potentially be switched to variable frequency drive (VFD) motors. This is beneficial for motors that are oversized and/or throttled back by valves. This would involve a capital cost, which would be made up over time from reduced energy usage. A cost-benefit analysis of installing VFDs would be appropriate after decisions are made regarding potential implementation of the other recommendations presented above (i.e., once future motor usage is clearly established).

The cost savings and level of up-front investment cannot be made until after the final configuration of pumps and motors is established (based on implementation of other recommendations).</td></tr>
<tr><td colspan="4">Resources Conserved:
☐ Hazardous air pollutants ☒ GHG emissions (CO2e) ☒ Energy ☒ Water ☐ Waste
☒ Criteria pollutants ☐ Safety/Community ☐ Materials ☐ Land-use</td></tr>
<tr><td colspan="2">Qualitative Net Cost Impact Over 5 Years, No Discounting

☐ Cost Increase ☐ Cost Savings
☐ Cost Neutral ☐ N/A</td><td colspan="2">☐ Recommended action otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="4">Attachment(s) to report with footprint assumptions and calculations:

Qualitative at this point, not yet quantified.</td></tr>
<tr><td>Implementation Status:

☐ Fully
☐ Partially
☒ Not Yet
☐ Not Planned</td><td colspan="3">Explanation of Status:

A cost-benefit analysis of installing VFDs would be appropriate after decisions are made regarding potential implementation of the other recommendations presented above (i.e., once future motor usage is clearly established).
`</td></tr>
</table>

Table 3-6
Tracking Table for Recommendation 3.6

<table>
<tr><td colspan="2">Recommendation:

3.6 - Consider pilot testing for vegetable oil as ERD substrate</td><td>Current Date:
1/26/12
Date of Original Recommendation:
1/26/12</td></tr>
<tr><td colspan="3">Basis for Recommendation (Include discussion of cost impacts and value if appropriate):

Based on the generic analysis presented in Section 2.8 and Appendix D:

• *If the vegetable oil half-life is 60 days, then there is a mixed result because most footprints (energy use, criteria pollutants, water use, materials use, and accident/fatality risk) are lower for the vegetable oil than for the molwhey, but greenhouse gas emissions are higher for the vegetable oil than for the molwhey.*

• *If the vegetable oil half-life is 90 days, then the footprint reductions (energy use, criteria pollutants, water use, materials use, and accident/fatality risk) are even greater for the vegetable oil, and the greenhouse gas emissions are nearly identical for the vegetable oil versus the molwhey.*

• *If the vegetable oil half-life is more than 90 days (e.g., 120 days), then all the footprints are lower for the vegetable oil versus the molwhey.*

Relative costs for the substrates were not quantified for this analysis.</td></tr>
<tr><td colspan="3">Resources Conserved:
☐ Hazardous air pollutants ☒ GHG emissions (CO2e) ☒ Energy ☒ Water ☐ Waste
☒ Criteria pollutants ☒ Safety/Community ☒ Materials ☐ Land-use</td></tr>
<tr><td colspan="2">Qualitative Net Cost Impact Over 5 Years, No Discounting

☐ Cost Increase ☐ Cost Savings
☐ Cost Neutral ☐ N/A</td><td>☐ Recommended action otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="3">Attachment(s) to report with footprint assumptions and calculations:

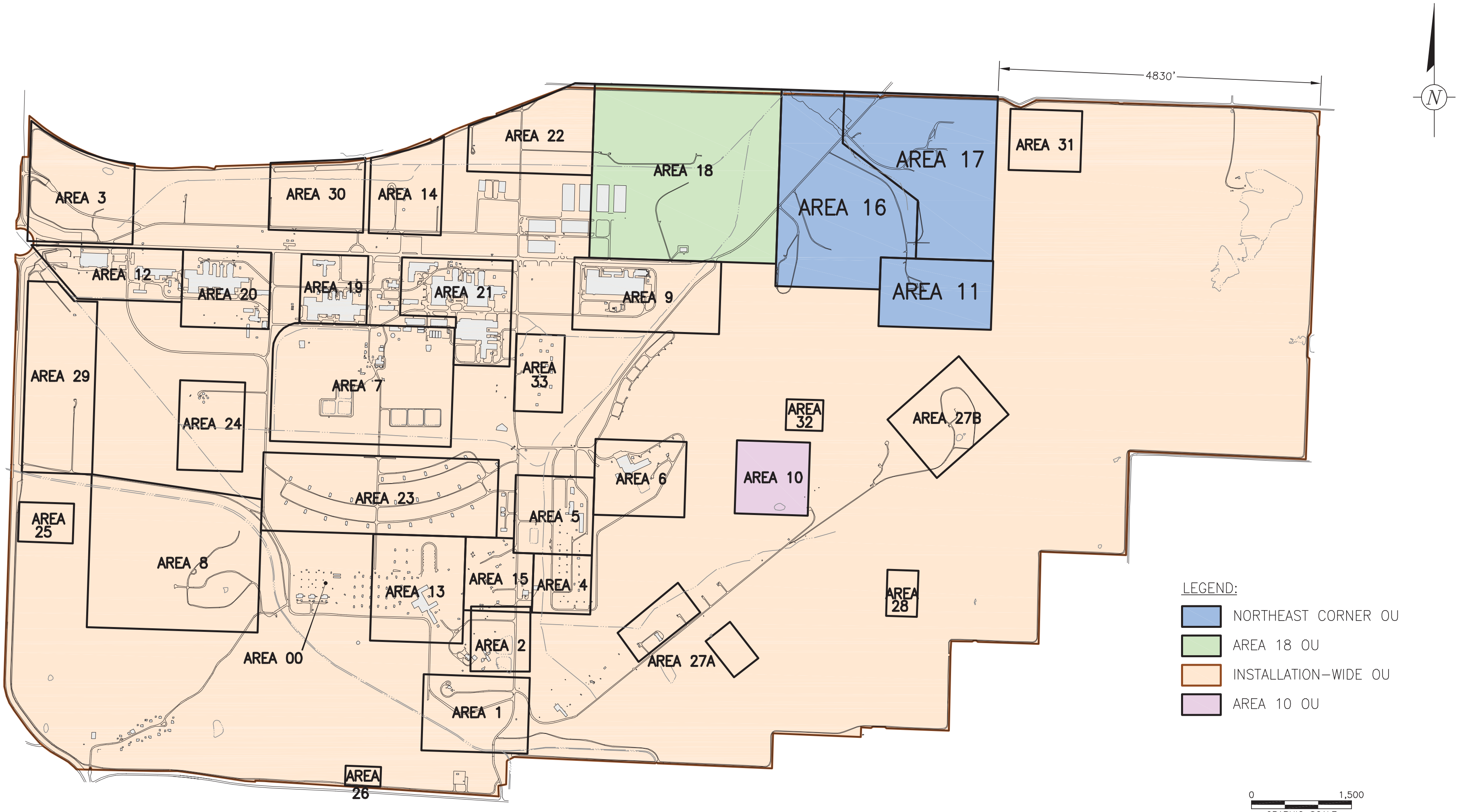
See Section2.8 and Appendix D.</td></tr>
<tr><td>Implementation Status:

☐ Fully
☐ Partially
☒ Not Yet
☐ Not Planned</td><td colspan="2">Explanation of Status:

This is a new recommendation for consideration by the Project Team.</td></tr>
</table>

FIGURES

Figure 1-1.



LAKE CITY ARMY AMMUNITION PLANT
INDEPENDENCE, MISSOURI
FIVE YEAR REVIEW

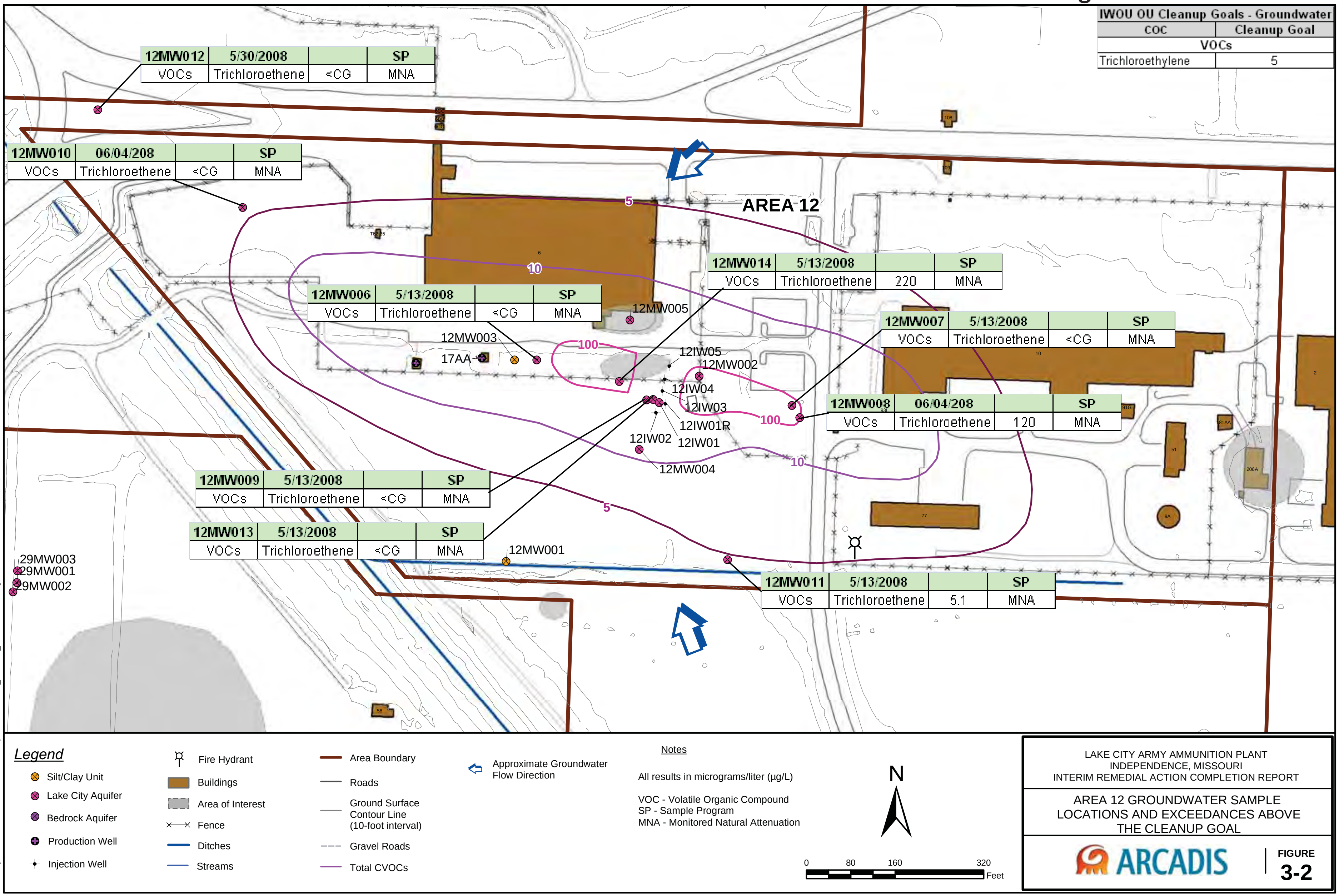
INSTALLATION LAYOUT

ARCADIS

FIGURE
3-2

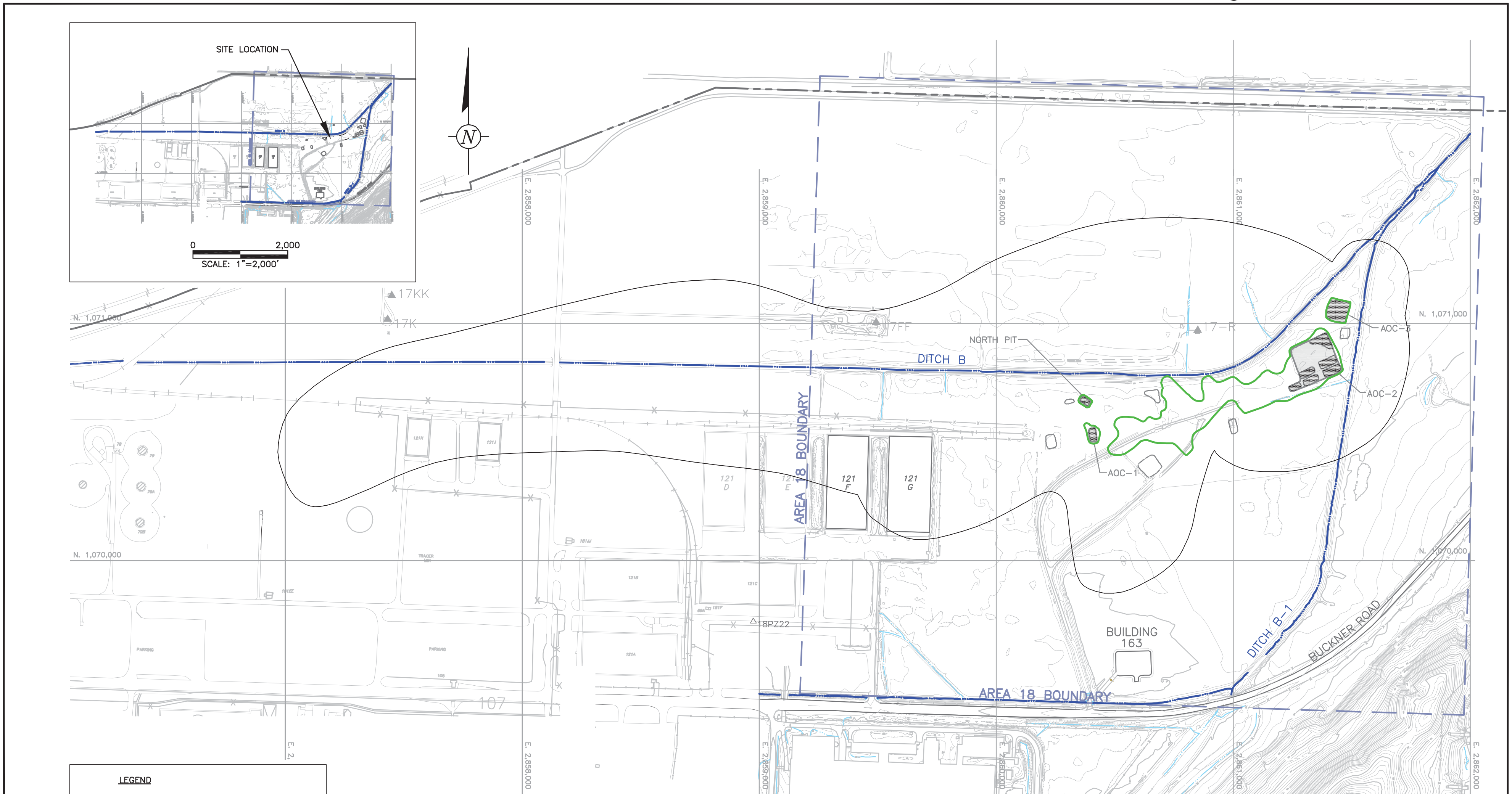
CITY:NEWTOWN-PA DIV/GROUP:141 DB:MW GHS LD:MW PIC:E. WERTH PM:P. MILIONIS TM:J. WILLIAMS LYR:(Opt)ON=*;OFF=*REF* G:\ENVCAD\Newtown\ACT\GP3\LCAAP\U002\UB001\3-2 - INSTALLATION LAYOUT.dwg LAYOUT: 3-2 SAVED: 4/23/2010 11:53 AM ACADVER: 17.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ARCADIS\NEWTOWN(SIZE A-B).CTB PLOTTED: 4/23/2010 11:53 AM BY: WASILEWSKI, MATT
XREFS: IMAGES: PROJECTNAME: ---
A5C06DE7DE0.dib

Figure 1-2.



CITY: Highlands Ranch, CO DIV/GROUP: AIT GIS DRAFTER: BCG
Project (GP3LCAAP)
G:\AProject\LCAAP\GIS\Geodatabase\Maps\IRACR\2008_Revised_012110\IWOU\Fig3-2 Area12.mxd - 2/6/2010 @ 2:19:28 PM

Figure 1-3.



LEGEND

17-R ▲ GROUNDWATER REMEDIATION EXTRACTION WELL

APPROXIMATE EXTENT OF SURFICIAL SOIL LEAD IMPACTS

APPROXIMATE EXTENT OF OU-WIDE GROUNDWATER.

NOTE:

SHALLOW VOC SOURCE AREAS ARE COMPRISED OF AOC-1, AOC-2, AOC-3 AND THE NORTH PIT.

0 400
SCALE: 1"=400'

LAKE CITY ARMY AMMUNITION PLANT
INDEPENDENCE, MISSOURI
INTERIM REMEDIAL ACTION COMPLETION REPORT

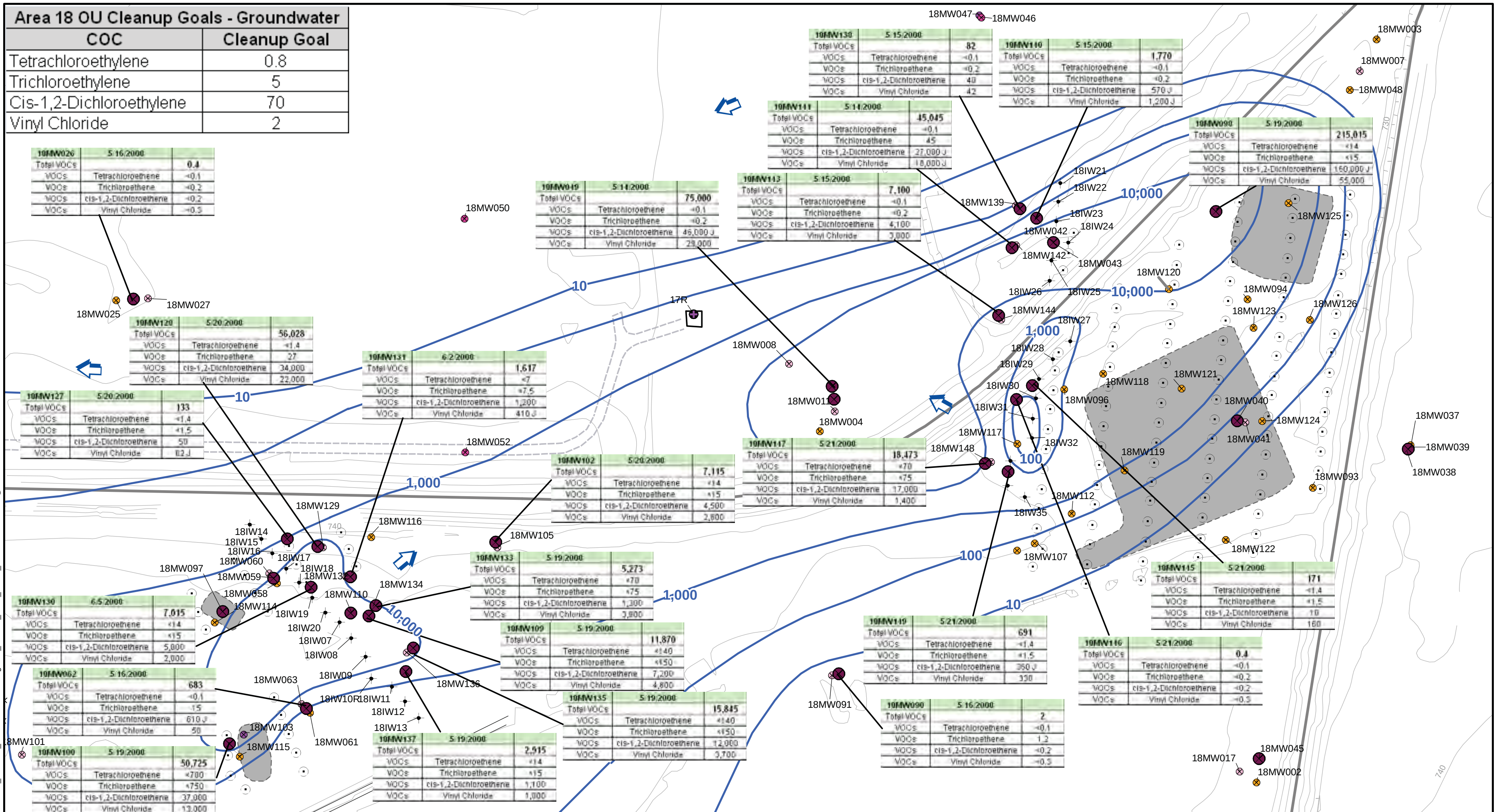
AREA 18 OU AREAS OF CONCERN

ARCADIS

FIGURE
4-1

Figure 1-4.

Area 18 OU Cleanup Goals - Groundwater	
COC	Cleanup Goal
Tetrachloroethylene	0.8
Trichloroethylene	5
Cis-1,2-Dichloroethylene	70
Vinyl Chloride	2



LEGEND

Silt/Clay Unit
Lake City Aquifer
Lake City Aquifer-Upper
Lake City Aquifer-Lower
Bedrock Aquifer
Production Well
Shallow RW
Injection Well
Area of Concern/Interest
Surface Elevation
Stream/Ditch
Fence
Railroad
Building
Gravel Road
Old Road
Direction of groundwater flow

Total Chlorinated Ethene isoconcentration contours in the upper paleochannel. Concentrations are presented in micrograms per liter (µg/L).

Notes:
1. Chlorinated ethenes include: cis-1,2-Dichloroethene, Tetrachloroethene, Trichloroethene, and Vinyl Chloride.
2. Monitoring well data collected during the Site-wide Annual Groundwater Monitoring Event conducted in May/June 2008.
3. ft bgs - feet below ground surface
4. Remedial Investigation data used as reference for contouring.
5. Half of the non-detect MDL values were used toward the total VOC value.

N

0 100 200 Feet

LAKE CITY ARMY AMMUNITION PLANT
INDEPENDENCE, MISSOURI
INTERIM REMEDIAL ACTION COMPLETION REPORT

AREA 18 TOTAL CHLORINATED ETHENES
IN THE UPPER PALEOCHANNEL
(32 - 65 FT BGS) - SOURCE AREA

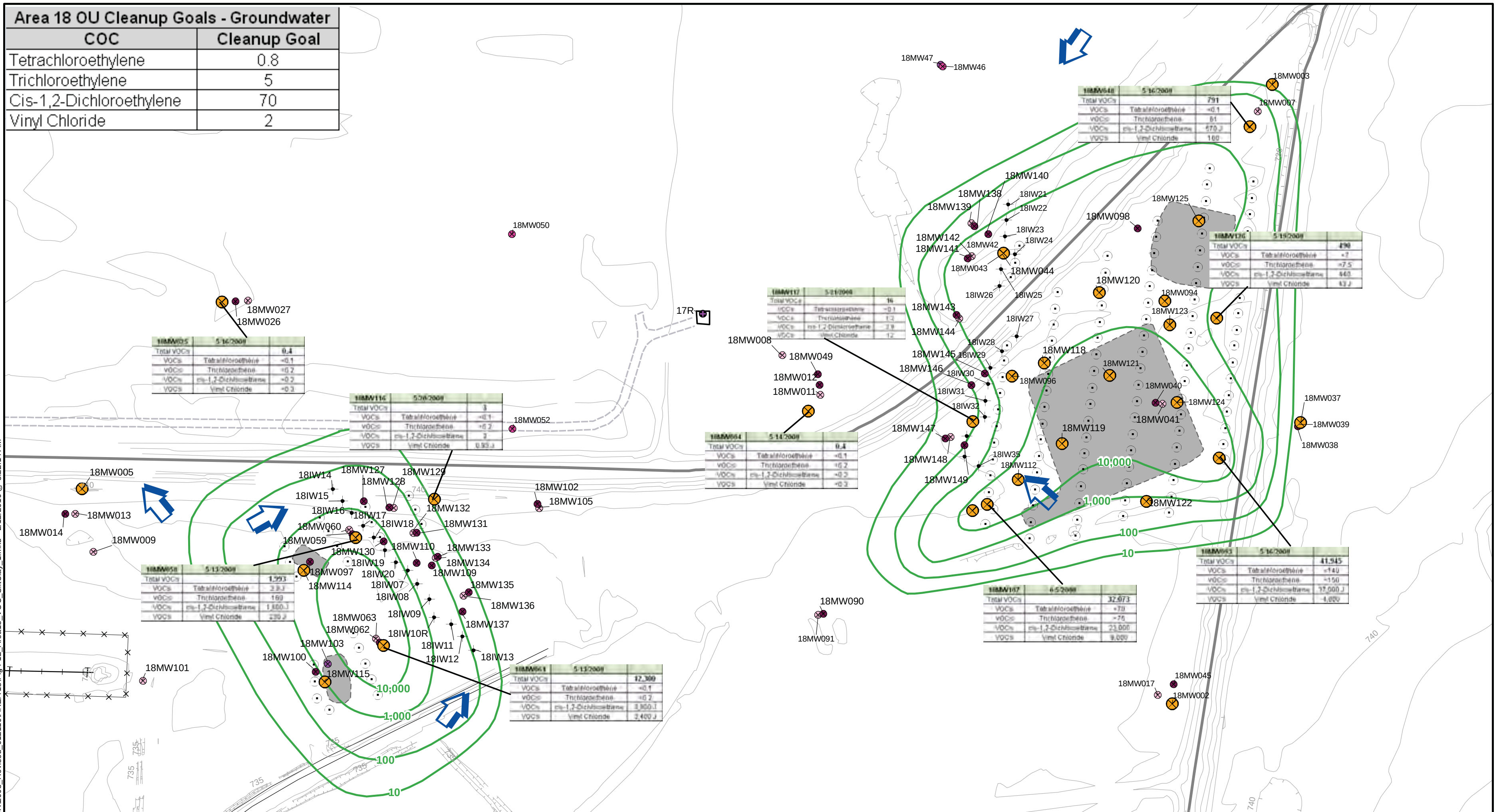
ARCADIS

FIGURE
4-13

CITY: Highlands Ranch, CO DIV/GROUP: AIT GIS DRAFTER: BCG
Project (GP3LCAAP)
G:\AProject\LCAAP\GIS\Geodatabase\Maps\IRACR\2008_Revised_012110\AREA 18\Fig4-13_Area18_VOC_LCUP_1.mxd - 2/12/2010 @ 8:22:09 AM

Figure 1-5.

Area 18 OU Cleanup Goals - Groundwater	
COC	Cleanup Goal
Tetrachloroethylene	0.8
Trichloroethylene	5
Cis-1,2-Dichloroethylene	70
Vinyl Chloride	2



CITY: Highlands Ranch, CO DIV/GROUP: IM GIS DRAFTER: BCG
Project (GP3LCAAP)
G:\AProject\LCAAP\GIS\Geodatabase\Maps\RACR\2008_Revised_012110\AREA 18\Fig4-12_Area18_VOC_SiltClay_1.mxd - 2/12/2010 @ 8:22:14 AM

LEGEND

- Silt/Clay Unit
- Lake City Aquifer
- Lake City Aquifer-Upper
- Lake City Aquifer-Lower
- Bedrock Aquifer
- Production Well
- Shallow RW
- Injection Well
- Area of Concern/Interest
- Surface Elevation
- Stream/Ditch
- Fence
- Railroad
- Building
- Gravel Road
- Old Road
- Direction of groundwater flow
- Total Chlorinated Ethene isoconcentration contours in the silt clay aquifer. Concentrations are presented in micrograms per liter (µg/L).

Notes:
1. Chlorinated ethenes include: cis-1,2-Dichloroethene, Tetrachloroethene, Trichloroethene, and Vinyl Chloride.
2. Monitoring well data collected during the Site-wide Annual Groundwater Monitoring Event conducted in May/June 2008.
3. ft bgs - feet below ground surface
4. Remedial Investigation data used as reference for contouring.
5. Half of the non-detect MDL values were used toward the total VOC value.

N

0 120 240 Feet

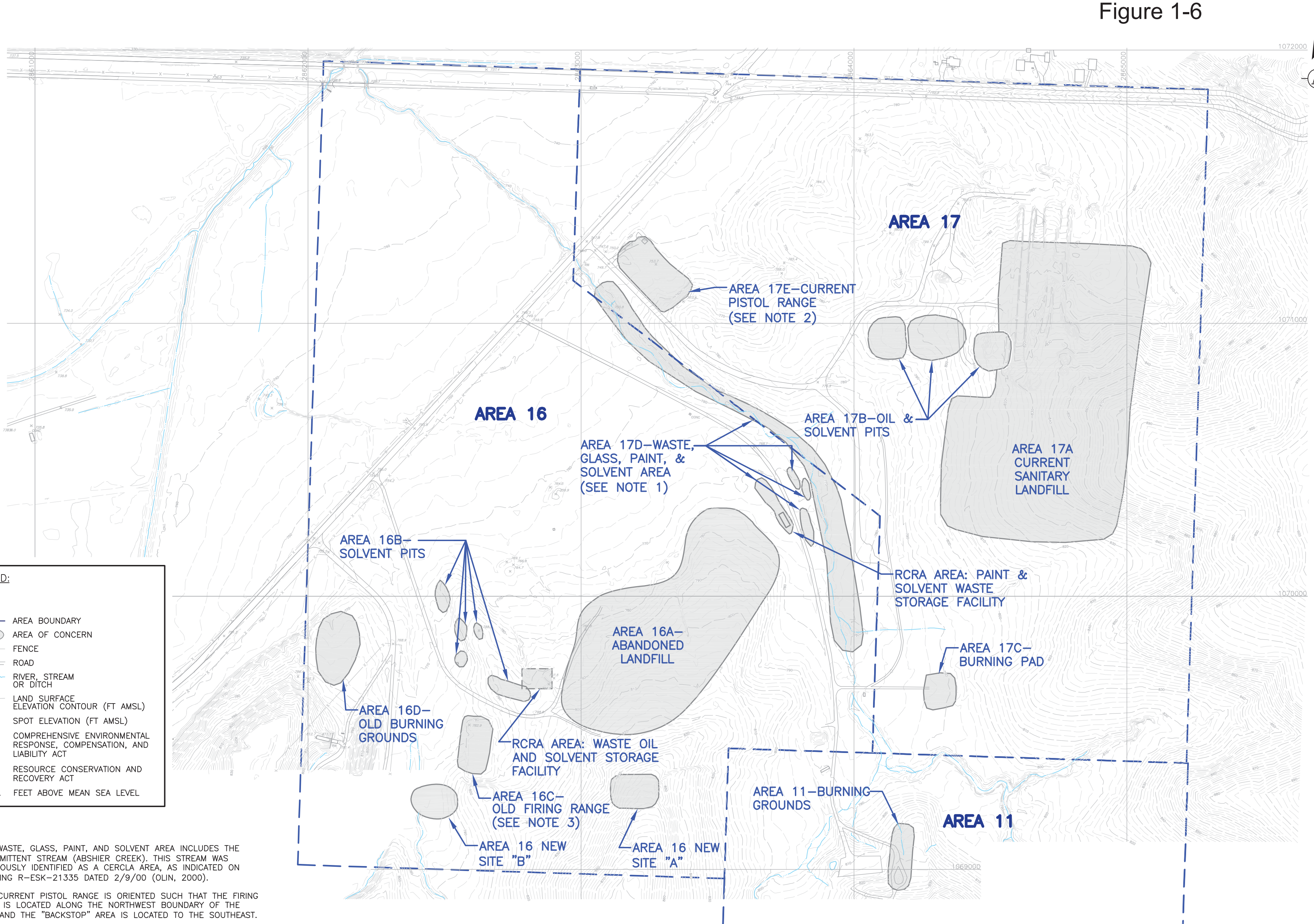
LAKE CITY ARMY AMMUNITION PLANT
INDEPENDENCE, MISSOURI
INTERIM REMEDIAL ACTION COMPLETION REPORT

AREA 18 TOTAL CHLORINATED ETHENES
IN THE SILT CLAY AQUIFER
(8 - 32 FT BGS) - SOURCE AREA

ARCADIS

FIGURE
4-12

Figure 1-6



LEGEND:

	AREA BOUNDARY
	AREA OF CONCERN
	FENCE
	ROAD
	RIVER, STREAM OR DITCH
	LAND SURFACE ELEVATION CONTOUR (FT AMSL)
	SPOT ELEVATION (FT AMSL)
CERCLA	COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT
RCRA	RESOURCE CONSERVATION AND RECOVERY ACT
FT AMSL	FEET ABOVE MEAN SEA LEVEL

NOTES:

1. THE WASTE, GLASS, PAINT, AND SOLVENT AREA INCLUDES THE INTERMITTENT STREAM (ABSHIER CREEK). THIS STREAM WAS PREVIOUSLY IDENTIFIED AS A CERCLA AREA, AS INDICATED ON DRAWING R-ESK-21335 DATED 2/9/00 (OLIN, 2000).
2. THE CURRENT PISTOL RANGE IS ORIENTED SUCH THAT THE FIRING AREA IS LOCATED ALONG THE NORTHWEST BOUNDARY OF THE AOC AND THE "BACKSTOP" AREA IS LOCATED TO THE SOUTHEAST.
3. THE OLD FIRING RANGE IS ORIENTED SUCH THAT THE FIRING AREA IS LOCATED ALONG THE NORTHERN BOUNDARY OF THE AOC AND THE "BACKSTOP" AREA IS LOCATED TO THE SOUTH.

LAKE CITY ARMY AMMUNITION PLANT
INDEPENDENCE, MISSOURI
FIVE-YEAR REVIEW

NECOU AREAS OF INTEREST

ARCADIS

FIGURE
7-1

Figure 1-7.

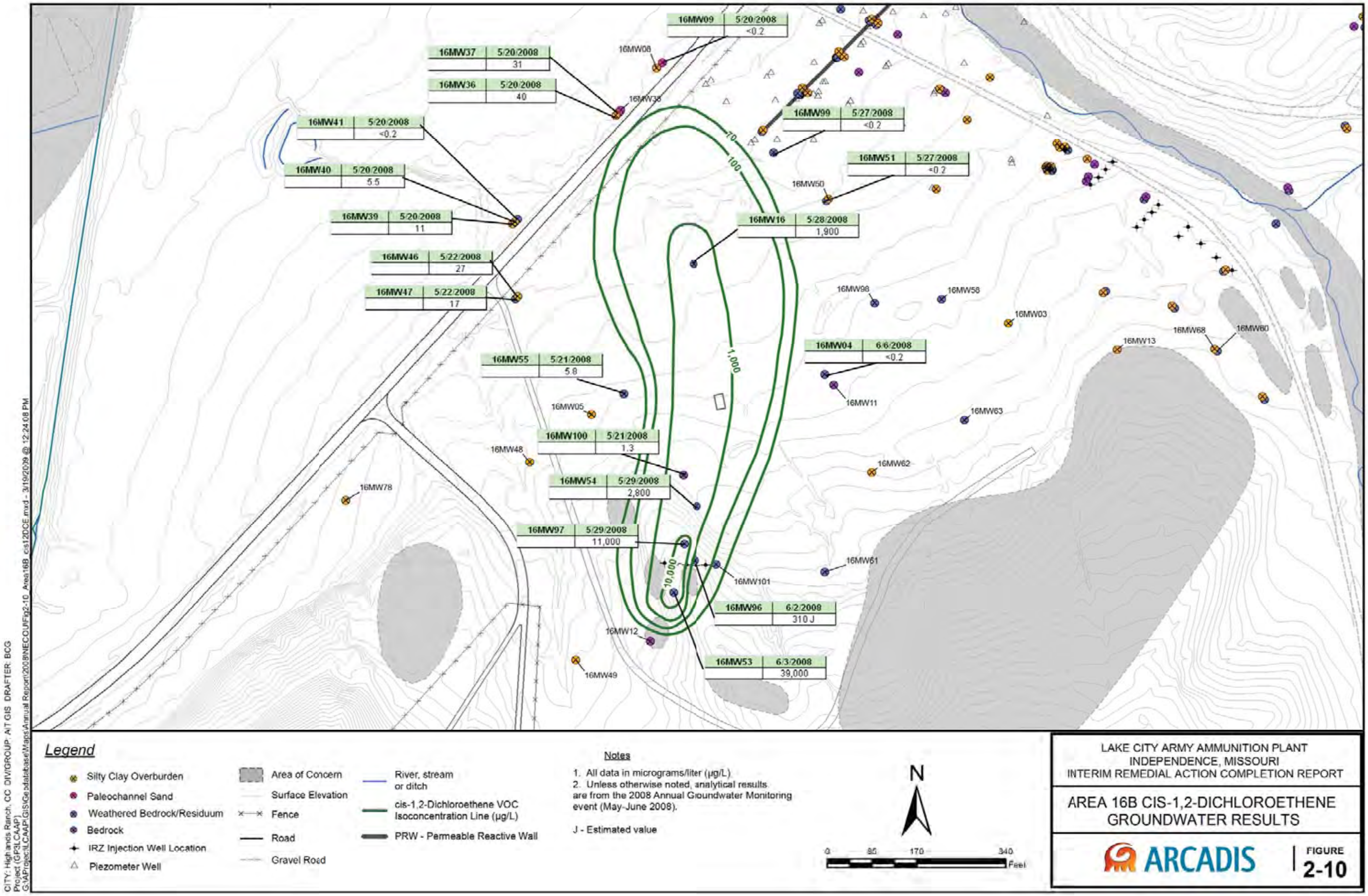

16MW09 5/20/2008 <0.2
16MW37 5/20/2008 31
16MW36 5/20/2008 40
16MW41 5/20/2008 <0.2
16MW40 5/20/2008 5.5
16MW39 5/20/2008 11
16MW46 5/22/2008 27
16MW47 5/22/2008 17
16MW99 5/27/2008 <0.2
16MW51 5/27/2008 <0.2
16MW16 5/28/2008 1,900
16MW04 6/6/2008 <0.2
16MW55 5/21/2008 5.8
16MW100 5/21/2008 1.3
16MW54 5/29/2008 2,800
16MW97 5/29/2008 11,000
16MW96 6/2/2008 310 J
16MW53 6/3/2008 39,000
16MW08
16MW38
16MW50
16MW98
16MW58
16MW03
16MW68
16MW60
16MW13
16MW11
16MW63
16MW05
16MW48
16MW62
16MW78
16MW61
16MW101
16MW12
16MW49
10
100
1,000
10,000
Legend
Silty Clay Overburden
Paleochannel Sand
Weathered Bedrock/Residuum
Bedrock
IRZ Injection Well Location
Piezometer Well
Area of Concern
Surface Elevation
Fence
Road
Gravel Road
River, stream or ditch
cis-1,2-Dichloroethene VOC Isoconcentration Line (µg/L)
PRW - Permeable Reactive Wall
Notes
1. All data in micrograms/liter (µg/L).
2. Unless otherwise noted, analytical results are from the 2008 Annual Groundwater Monitoring event (May-June 2008).
J - Estimated value
N
0 85 170 340 Feet
LAKE CITY ARMY AMMUNITION PLANT
INDEPENDENCE, MISSOURI
INTERIM REMEDIAL ACTION COMPLETION REPORT
AREA 16B CIS-1,2-DICHLOROETHENE GROUNDWATER RESULTS
ARCADIS
FIGURE 2-10
CITY: Highlands Ranch, CO DIV/GROUP: AIT GIS DRAFTER: BCG
Project (GP3LCAAP)
G:\AProject\LCAAP\GIS\Geodatabase\Maps\Annual Report\2008\NECOU\Fig2-10_Area16B_cis12DCE.mxd - 3/19/2009 @ 12:24:08 PM

Figure 1-8.

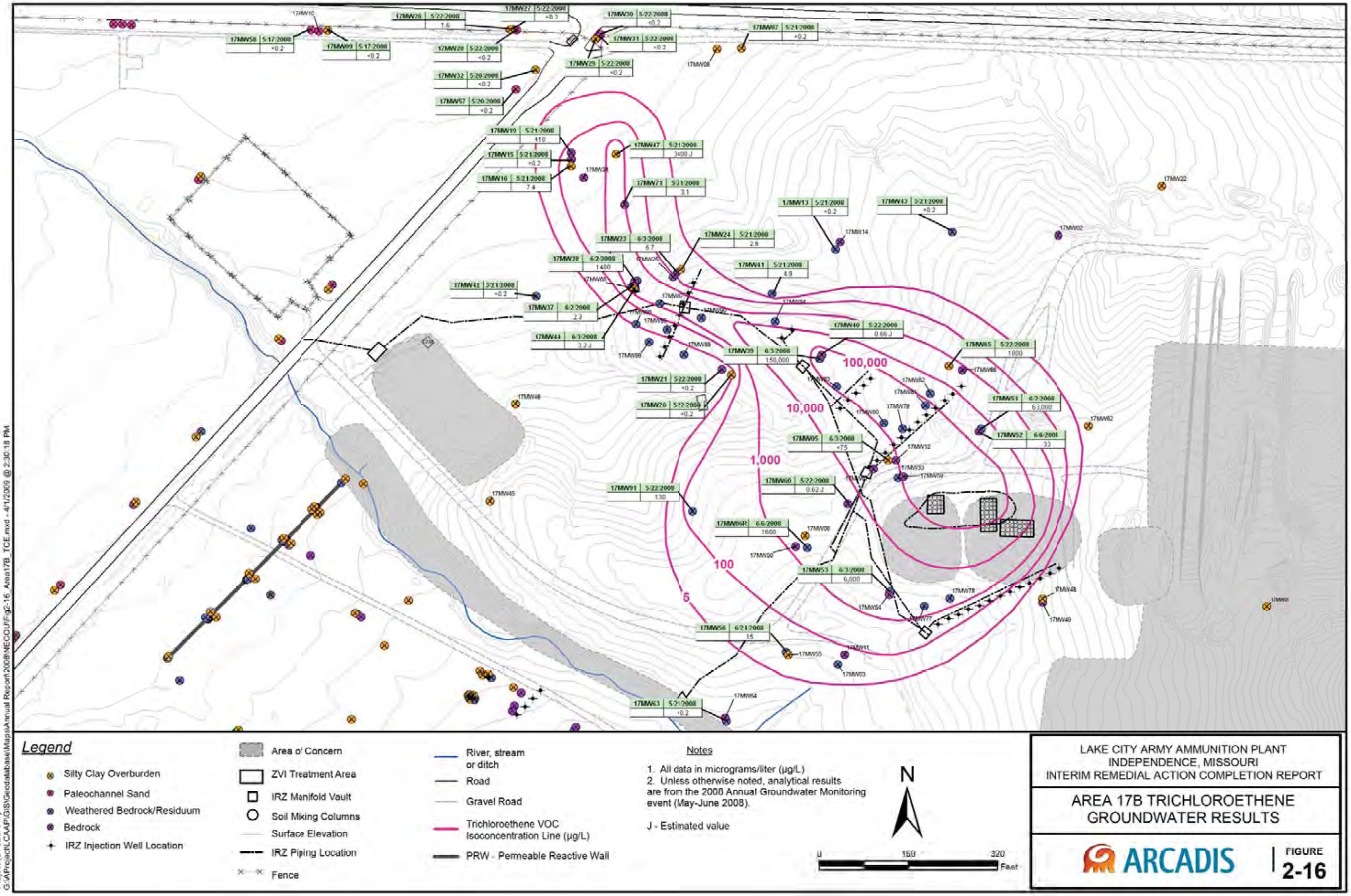
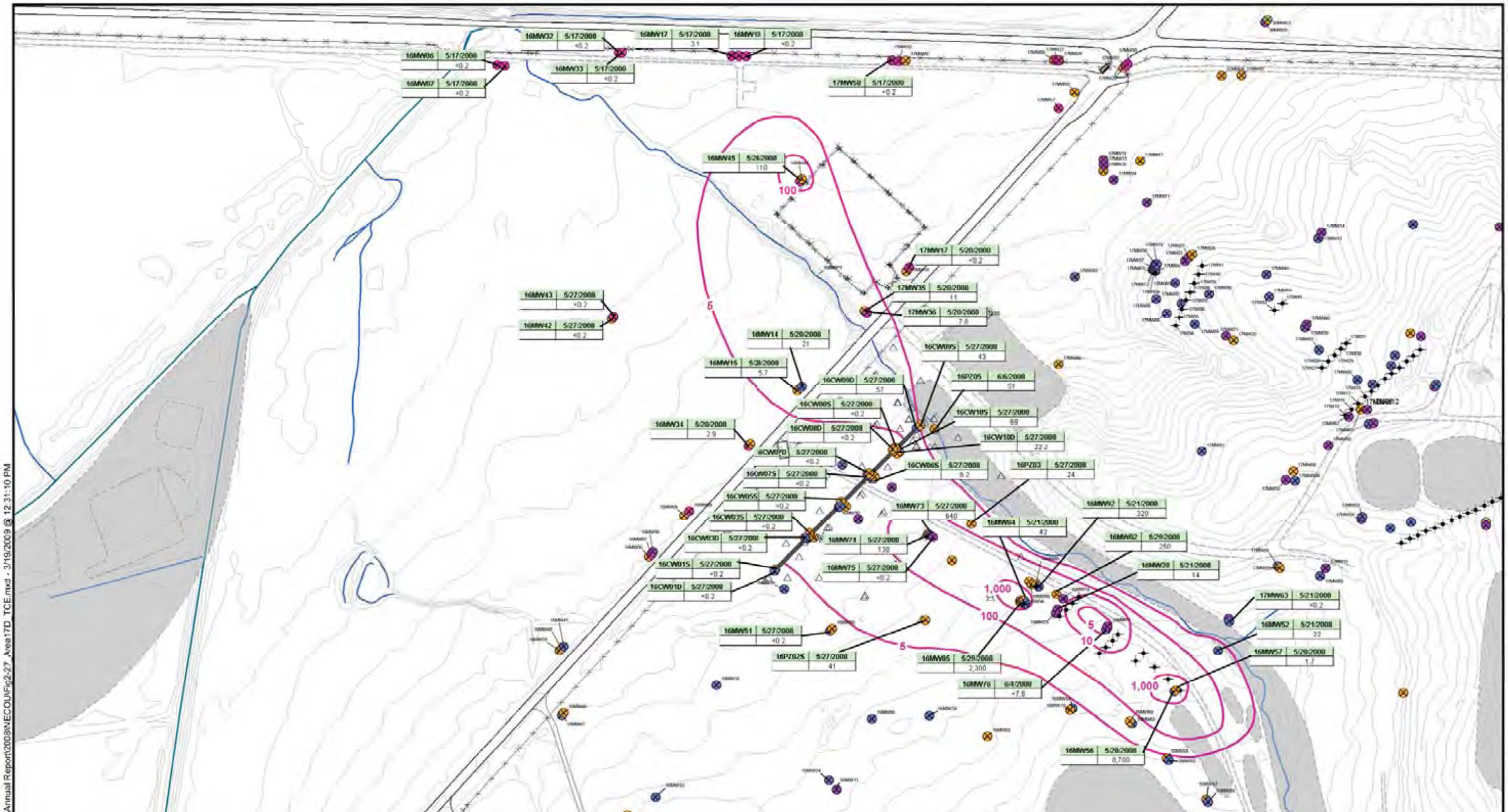

100,000
10,000
1,000
100
5
Legend
Silty Clay Overburden
Paleochannel Sand
Weathered Bedrock/Residuum
Bedrock
IRZ Injection Well Location
Area of Concern
ZVI Treatment Area
IRZ Manifold Vault
Soil Mixing Columns
Surface Elevation
IRZ Piping Location
Fence
River, stream or ditch
Road
Gravel Road
Trichloroethene VOC Isoconcentration Line (µg/L)
PRW - Permeable Reactive Wall
Notes
1. All data in micrograms/liter (µg/L)
2. Unless otherwise noted, analytical results are from the 2008 Annual Groundwater Monitoring event (May-June 2008).
J - Estimated value
N
0
160
320
Feet
LAKE CITY ARMY AMMUNITION PLANT
INDEPENDENCE, MISSOURI
INTERIM REMEDIAL ACTION COMPLETION REPORT
AREA 17B TRICHLOROETHENE
GROUNDWATER RESULTS
ARCADIS
FIGURE
2-16

Figure 1-9.



CITY: Highlands Ranch, CO DIV/GROUP: AIT GIS DRAFTER: BCG
Project (GP3LCAAP)
G:\AProject\LCAAP\GIS\Geodatabase\Maps\Annual Report\2008\NECOU\Fig2-27_Area17D_TCE.mxd - 3/19/2009 @ 12:31:10 PM

Legend

- Silty Clay Overburden
- Paleochannel Sand
- Weathered Bedrock/Residuum
- Bedrock
- IRZ Injection Well Location
- Piezometer Well
- Area of Concern
- Fence
- Surface Elevation
- River, stream or ditch
- Road
- Gravel Road
- Trichloroethene VOC Isoconcentration Line (µg/L)
- PRW - Permeable Reactive Wall

Notes

1. All data in micrograms/liter (µg/L)
2. Unless otherwise noted, analytical results are from the 2008 Annual Groundwater Monitoring event (May-June 2008).

J - Estimated value

N

0 110 220 440 Feet

LAKE CITY ARMY AMMUNITION PLANT
INDEPENDENCE, MISSOURI
INTERIM REMEDIAL ACTION COMPLETION REPORT

AREA 17D TRICHLOROETHENE GROUNDWATER RESULTS

ARCADIS

FIGURE 2-27

APPENDIX A

Best Management Practice (BMP) Tables

Please note that, for this pilot project, GSR BMP tables in Appendix A were filled out **<u>for the P&T systems only.</u>** Groundwater treatment at LCAAP also includes in-situ treatment, which consists primarily of enhanced reductive dechlorination (ERD) via injection of organic carbon substrate. Although this GSR evaluation includes a generic evaluation of quantitative footprints for three different ERD substrates (molasses, molwhey, and vegetable oil), the major focus of this pilot project GSR evaluation (i.e., for this Study) is the P&T systems, and the evaluation of GSR BMPs was only performed with respect to the P&T systems.

BMP Category A: Planning

BMP A-1: Develop a culture of GSR within the Project Team and encourage GSR ideas from project staff	**Date:** 1/26/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☒ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☒ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *There has not been a clear emphasis on GSR concepts to date for the P&T groundwater remedies at this site.*	

BMP A-2: Incorporate a section on GSR in project meetings, work plans, and reports	**Date:** 1/26/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☒ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☒ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *The July 2010 RSE Report includes a sustainability evaluation, however, that was a not a report produced by the Project Team.*	

BMP Category A: Planning

BMP A-3: Identify and periodically update a list of key stakeholders and their concerns with respect to GSR considerations	**Date:** 1/26/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☒ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☒ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Not clear if key stakeholders have been asked their concerns regarding GSR. Stakeholders have not indicated concerns regarding GSR considerations, and the Army has not specifically brought up GSR considerations with regulators.*	

BMP A-4: Schedule activities for appropriate seasons and/or time of day to reduce delays caused by weather conditions and fuel needed for heating or cooling Examples: - Work at night in summer to avoid heat stress - Perform field activities in summer to take advantage of longer daylight	**Date:** 1/26/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *The P&T remedies are not impacted by the seasons.*	

BMP A-5: Prepare, store, and distribute documents electronically	**Date:** 1/26/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? (“N/A” if “Practical” not checked) ☐ Fully ☒ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☐ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

A digital data repository is used to store and provide access to report. The RSE noted some documents were not available from that repository.

BMP A-6: Utilize teleconferences rather than meetings when feasible	**Date:** 1/26/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? (“N/A” if “Practical” not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

The project team uses teleconferences when feasible.

BMP A-7: Incorporate green specifications into solicitations and contracts
Examples:
- Follow pertinent green procurement policies
- Select hotel chains with "green" policies
- Select laboratories that utilize renewable energy

Date: 1/26/12
☒ Applicable
☐ Evaluated
☐ Practical

Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☒ Hazardous air pollutants ☒ Energy ☒ Waste
☒ Criteria pollutants ☒ Materials ☒ Safety/Community
☒ GHG emissions (CO2e) ☒ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

The RSE did not determine if there are green specifications in any contracts for any of the contractors.

BMP A-8: Integrate schedules to allow for resource sharing and fewer days of field mobilization

Date: 1/26/12
☒ Applicable
☒ Evaluated
☒ Practical

Implemented?
("N/A" if "Practical" not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☒ Economic ☒ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☒ Hazardous air pollutants ☒ Energy ☐ Waste
☒ Criteria pollutants ☐ Materials ☒ Safety/Community
☒ GHG emissions (CO2e) ☐ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

The same staff work on the Building 163 and water supply P&T systems.

BMP Category A: Planning

BMP A-9: Explore multiple site re-use options, including those that include some restriction of site re-use and related resource conservation	**Date:** 1/26/12 ☒ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☒ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *- currently used as small arms manufacturing facility for army* *- Might be possible to use available land on the installation for growing biomass (trees or crops) to remove carbon dioxide and, in some cases, allow for harvesting for other use such as energy production. That has not been fully evaluated.*	

BMP A-10: Conduct thorough review of project documents and historical records to minimize required scope of investigation Examples: - IRP projects: determine if there are previous aquifer tests that can be used for groundwater modeling rather than conducting new aquifer tests - MMRP projects: perform careful review of historic documents, aerial photographs, and other existing information to reduce the footprint of land that needs to be disturbed for thorough investigation and remediation - MMRP projects: use IRP sampling data to supplement and enhance the MMRP field program (if available)	**Date:** 1/26/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☒ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *- The RSE noted that it was not easy to obtain information regarding the supply wells and associated strippers, or the discharge permit for Building 163.*	

BMP Category B: Characterization and/or Remedy Approach

BMP B-1: Develop and routinely update a conceptual site model (CSM) to use as a basis for making remedial process decisions	**Date:** 1/26/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☒ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☒ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☒ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☒ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

- CSM exists, but target capture zones need to be clearly established (along with flow directions with and without pumping)

BMP B-2: Perform frequent optimization evaluations to improve efficiency of current or planned actions and/or develop alternative remedial approaches that might shorten remedy duration or otherwise improve the net environmental benefit of the remedy	**Date:** 1/26/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☒ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☒ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☐ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

- RSE recently performed in summer 2010, gives recommendations for system optimization and remedial approaches. Not clear if recommendations have been considered for implementation.

BMP Category B: Characterization and/or Remedy Approach

<table>
<tr><td colspan="3">BMP B-3: Use appropriate characterization or remedy approach based on site conditions
Examples:
- Consider in-situ and passive remedy options that offer adequate protectiveness
- Consider in-situ bioremediation if conditions are already anaerobic and constituents are conducive to reductive dechlorination
- Compare source removal versus in-situ and ex-situ remedial options
- Consider different technologies for impacted areas with higher and lower concentrations
- Use realistic times to remedy closeout (i.e., estimations through modeling) rather than assumed remedy timeframes (e.g., 30 years), which is often used for evaluation of FS alternatives
- MMRP projects: evaluate man-portable DGM instruments versus vehicle-towed array (VTA) instruments and inclusion of detector-aided reconnaissance (DAR)</td><td>Date: 1/26/12

☒ Applicable
☒ Evaluated
☒ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☐ Fully ☐ Partially ☒ Not Yet ☐ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
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☒ Criteria pollutants ☒ Materials ☐ Safety/Community
☒ GHG emissions (CO2e) ☒ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

Not clear that de-centralized strippers on supply wells is appropriate. Not clear that CATOX is needed at Building 163. Not clear that any treatment is actually required at Building 163 prior to discharge to POTW.</td></tr>
</table>

BMP Category B: Characterization and/or Remedy Approach

<table>
<tr><td colspan="3">BMP B-4: Establish decision points to trigger a change from one technology to another or from one remedy alternative to another
Examples:
- Change vapor treatment from thermal oxidation to granular activated carbon (GAC) media based on flow rates and concentrations
- Remove a treatment polishing step if influent to that step already meets discharge criteria
- Move to Monitored Natural Attenuation (MNA) if specific concentration thresholds in groundwater are met</td><td>Date: 1/26/12

☒ Applicable
☒ Evaluated
☒ Practical</td></tr>
<tr><td>Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☒ Not Yet ☐ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting
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If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

Not clear if there is a decision framework for terminating treatment components such as CATOX or entire Building 163 system.</td></tr>
</table>

BMP Category B: Characterization and/or Remedy Approach

<table>
<tr><td colspan="3">BMP B-5: Focus sampling efforts to meet objectives of the specific remedial phase (e.g., sampling during O&M should be focused on evaluating remedy performance and not on thorough plume characterization)
Examples:
- Eliminate sampling parameters as appropriate
- Reduce sampling frequency as appropriate
- Reduce sample locations as appropriate
- Enhance monitoring program as appropriate
- MMRP projects: consider Incremental Sampling Methodology (ISM) versus discrete sampling for MC characterization</td><td>Date: 1/26/12

☒ Applicable
☒ Evaluated
☒ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
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If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

- RSE recommends reducing sampling frequency of VOC monitoring at building 163</td></tr>
</table>

BMP Category B: Characterization and/or Remedy Approach

<table>
<tr><td colspan="2">BMP B-6: Consider real-time measurements and dynamic work plans to reduce mobilizations and improve effectiveness of investigation efforts
Examples:
- Field test kits (e.g., test kits for sulfate)
- Field screening instruments (e.g., x-ray fluorescence for lead or photoionization detectors for volatile organics)
- Drive point sensor technologies (e.g., membrane interface probe or “MIP”)
- Visual staining or odor
- Establish excavation extent based on real-time data collected as excavation proceeds and use GPS to accurately delineate excavation areas
- MMRP projects: use GPS and/or the same equipment that was used for detection to confirm anomaly signatures prior to excavating
- MMRP projects: consider incorporating field screening methods (e.g., X-ray fluorescence, EXPRAY and explosives test kits, as appropriate or applicable) into the field program to refine sampling locations and reduce the quantities of samples submitted for off-site laboratory analysis</td><td>Date: 1/26/12

☐ Applicable
☐ Evaluated
☐ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A</td><td colspan="2">Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
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If checked, required by:</td></tr>
<tr><td colspan="3">Notes (including discussion of possible value of implementing the BMP):

RSE recommends eliminating continuous analyzer for CATOX (data not needed).</td></tr>
</table>

BMP Category B: Characterization and/or Remedy Approach

BMP B-7: Consider use of existing site structures/infrastructure or mobilization of temporary structures versus new construction Examples: - Buildings (e.g., for treatment building or field office) - Concrete slabs or foundations - Wells - Existing excavations for storm water control	**Date:** 1/26/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☒ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☒ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☐ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *The aerator for the Installation Water Treatment Plant could be expanded to treat water from the supply wells, so the individual strippers and transfer pumps could be eliminated.*	

BMP B-8: Establish project-specific decision points to limit extent of remediation Examples: - Project-specific cleanup levels based on a site-specific risk assessment (coordinated with risk assessment experts) rather than generic cleanup levels, if it results in lower footprints for key parameters and is acceptable to all stakeholders - MMRP projects: dig stopping rules and anomaly prioritization/detection criteria to minimize false positives	**Date:** 1/26/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☒ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
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Notes (including discussion of possible value of implementing the BMP): *- need to determine basis for criteria for water sent to POTW*	

BMP Category B: Characterization and/or Remedy Approach

<table>
<tr><td colspan="3">BMP B-9: Consider leaving in place structures whose removal is not necessary (i.e., foundations, underground pillars, etc.)</td><td>Date: 1/26/12
☐ Applicable
☐ Evaluated
☐ Practical</td></tr>
<tr><td>Implemented?
("N/A" if "Practical" not checked)
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(discuss in notes if necessary):
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If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):</td></tr>
</table>

BMP C-1: Reduce the number of trips for personnel Examples: - Encourage carpooling - Use telemetry systems and webcams to remotely transmit data directly to project offices to avoid trips	**Date:** 1/26/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
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Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☐ Waste ☒ Criteria pollutants ☐ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Carpooling is encouraged.*	

BMP C-2: Reduce the number of trips and/or volume for transported materials, equipment, or waste Examples: - Transfer full loads by consolidating shipments from vendors and/or shipments to disposal sites (also share shipments with neighbors if feasible) - Purchase more concentrated chemicals to reduce transportation weight and/or volume	**Date:** 1/26/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
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Notes (including discussion of possible value of implementing the BMP): *Small amounts of waste from P&T system are consolidated with other Installation wastes*	

BMP Category C: Energy/Emissions – Transportation

BMP C-3: Reduce trip lengths Examples: - Dispose of waste at closest appropriate facility - Purchase materials, equipment, and services from local vendors - Use locally produced supplies - Select most efficient transportation route	**Date:** 1/26/12 ☒ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
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Notes (including discussion of possible value of implementing the BMP): *-Not evaluated.*	

BMP C-4: Use alternate fuels or other options for transportation when possible Examples: - Compressed natural gas - Biodiesel blends - Ethanol blends - Hybrid and/or electric - Rail lines versus trucks - Use a fuel efficient passenger car rather than a pickup truck if task allows	**Date:** 1/26/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
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Notes (including discussion of possible value of implementing the BMP):	

BMP Category D: Energy/Emissions – Equipment Use

BMP D-1: Consider and implement approaches to minimize engine idle times	**Date:** 1/26/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
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Notes (including discussion of possible value of implementing the BMP):	

BMP D-2: Ensure peak operating efficiency of equipment to reduce energy use and emissions Examples: - Perform preventative maintenance and operate equipment per manufacturer instructions - Perform retrofits involving low-maintenance multi-stage filters for cleaner engine exhaust - Use synthetic oil to extend operating life (and reduce waste oil) - Purchase newer equipment with reduced emissions	**Date:** 1/26/12 ☒ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
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Notes (including discussion of possible value of implementing the BMP):	

BMP Category D: Energy/Emissions – Equipment Use

<table>
<tr><td colspan="3">BMP D-3: Use alternate fuel options for equipment when possible
Examples:
- Compressed natural gas
- Biodiesel
- Ethanol blends
- Ultra-low sulfur diesel, wherever available (and as required by engines with PM traps)</td><td>Date: 1/26/12
☐ Applicable
☐ Evaluated
☐ Practical</td></tr>
<tr><td>Implemented?
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</table>

<table>
<tr><td colspan="3">BMP D-4: Select appropriate equipment and/or power source for the job
Examples:
- Avoid using large excavators for small earthmoving projects
- Use direct push methods when possible to reduce drilling duration
- Compare potential use of electricity versus battery versus generator</td><td>Date: 1/26/12
☐ Applicable
☐ Evaluated
☐ Practical</td></tr>
<tr><td>Implemented?
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</table>

BMP Category D: Energy/Emissions – Equipment Use

<table>
<tr><td colspan="3">BMP D-5: Use variable frequency drives on motors (e.g., pumps, blowers), or replace oversized motors with properly sized motors</td><td>Date: 1/26/12
☒ Applicable
☐ Evaluated
☐ Practical</td></tr>
<tr><td>Implemented?
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☐ Fully ☐ Partially ☐ Not Yet ☒ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting
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<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

- VFDs could be installed on the pumps for the extraction wells. This is beneficial for motors that are oversized and/or throttled back by valves. This would involve a capital cost, which would be made up over time from reduced energy usage. A cost-benefit analysis of installing VFDs would be appropriate after decisions are made regarding potential implementation of the other RSE recommendations (i.e., once future motor usage is clearly established).</td></tr>
</table>

<table>
<tr><td colspan="3">BMP D-6: Identify options for generating renewable energy for direct use in the remedy and/or for alternate use at or near the project site
Examples:
- Solar, wind, landfill gas (microturbines), combined heat and power, geothermal heat exchange
- Applications for remote areas such as solar pumps or solar flares (if demand is not continuous, the need for a battery backup may be avoided)
- Generate power or heat exchange from water to be discharged</td><td>Date: 1/26/12
☒ Applicable
☐ Evaluated
☐ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social</td><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="2">Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

- could use some land for growing biomass</td></tr>
</table>

BMP Category D: Energy/Emissions – Equipment Use

BMP D-7: Consider purchase of renewable energy certificates to offset emissions from the remedial activities	**Date:** 1/26/12 ☒ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Not evaluated.*	

BMP D-8: Design/modify housing required for above-ground treatment components for energy-efficiency Examples: - Passive lighting - Compact fluorescent lighting (CFL) or light-emitting diode (LD) lighting - Timers and/or motion control sensors for lighting - Shading - Minimize heating and cooling needs (building size, insulation, etc.)	**Date:** 1/26/12 ☒ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Not evaluated.*	

BMP Category D: Energy/Emissions – Equipment Use

BMP D-9: For remedies that involve groundwater or air extraction, optimize extraction to reduce flow rates (potentially beneficial with respect to energy use, materials usage, water resources, waste disposal, etc.)	**Date:** 1/26/12 ☒ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

- potentially applicable
- At supply well 17AA in Area 12, the remedy reportedly requires only 50 gpm of pumping (based on modeling) for addressing plume containment as per the ROD, but a higher rate (~240 gpm based on the IRACR) is actually extracted from well 17AA for use as water supply.
- If Building 163 water was used for water supply rather than sent to POTW, amount of extraction from supply wells could be reduced

BMP D-10: Consider pulsing for extraction of water or air to maximize mass removal per unit of time or energy, by extracting higher concentrations	**Date:** 1/26/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

BMP Category D: Energy/Emissions – Equipment Use

<table>
<tr><td colspan="3">BMP D-11: Run electrical equipment during times of lower electric demand if possible (this does not reduce energy use but could lower cost and also can lower stress on the energy grid during periods of peak demand)</td><td>Date: 1/26/12
☐ Applicable
☐ Evaluated
☐ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
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If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):</td></tr>
</table>

BMP Category E: Materials & Off-Site Services

BMP E-1: Use materials that are made from recycled materials Examples: - Steel - Asphalt - Plastics - Concrete	**Date:** 1/26/12 ☒ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Very few materials used for the P&T systems, but has not really been evaluated.*	

BMP E-2: Optimize the amount of materials used Examples: - Experiment with different material amounts/doses - Consider alternate materials - Use timers or feedback loops and process controls for dosing - MMRP projects: minimize quantities of donor explosives for MEC destruction	**Date:** 1/26/12 ☒ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☒ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Very few materials used for the P&T systems, but has not really been evaluated.*	

BMP Category E: Materials & Off-Site Services

BMP E-3: Utilize less refined materials when feasible

Examples:

- Limestone instead of sodium hydroxide for pH adjustment
- Native fill instead of select fill

Date: 1/26/12

☒ Applicable ☐ Evaluated ☐ Practical

Implemented? ("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☐ Not Yet ☐ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☒ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Very few materials used for the P&T systems, but has not really been evaluated.

BMP E-4: Identify opportunities for using by-products or "waste" materials from local sources in place of refined chemicals or materials

Examples:

- Cheese whey, molasses, compost, or off-spec food products for inducing anaerobic conditions
- Crushed concrete for use as fill
- Concrete from coal combustion byproducts

Date: 1/26/12

☒ Applicable ☐ Evaluated ☐ Practical

Implemented? ("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☒ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Very few materials used for the P&T systems, but has not really been evaluated.

BMP E-5: Reduce demand on Publicly Owned Treatment Works (POTWs) Examples: - Discharge treated water to groundwater or to surface water rather than POTW - Minimize amount of water requiring treatment	**Date:** 1/26/12 ☒ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☒ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

- RSE recommends evaluating the feasibility of discharging water from building 163 to the IWTP rather than the POTW. His has not yet been fully evaluated since information regarding influent levels allowed by the POTW has not been provided. However, PM indicates this is not likely to be implemented.

BMP Category F: Water Resource Use

BMP F-1: Minimize water consumption
Examples:
- Sensors to turn off water when not needed
- Low flow fittings
- Minimize water needs for irrigation (landscape choices, use of mats and mulch)

Date: 1/26/12
☒ Applicable
☐ Evaluated
☐ Practical

Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☒ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

If Building 163 water was used for water supply rather than sent to POTW, amount of extraction from supply wells could be reduced. This has not been fully evaluated. However, PM indicates this is not likely to be implemented.

BMP F-2: Preferentially use less refined water resources when feasible
Examples:
- Use extracted groundwater instead of potable water for chemical blending
- Capture and store rain/storm water for future use
- Employ rumble grates with a closed-loop gray-water washing system

Date: 1/26/12
☐ Applicable
☐ Evaluated
☐ Practical

Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☒ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

BMP F-3: Use extracted and treated water for beneficial purposes Examples: - Irrigation - Potable water - Industrial process water	**Date:** 1/26/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☒ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *- water from several wells is already extracted, pre-treated, and sent to the IWTP for use as water supply*	

BMP F-4: Promote groundwater recharge Examples: - Recharge extracted and treated water when beneficial uses of the water are not identified and reinjection is practical - Minimize site area covered by impervious surfaces to reduce runoff and maximize infiltration (unless such capping is a specific component of the remedial action)	**Date:** 1/26/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP):	

<table>
<tr><td colspan="3">BMP F-5: Maintain water quality by preventing nutrient loading to surface water or groundwater
Examples:
- Use phosphate-free detergents instead of organic solvents or acids to decontaminate sampling equipment (if not required for some contaminants)</td><td>Date: 1/26/12
☐ Applicable
☐ Evaluated
☐ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☐ Economic ☐ Social</td><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
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<tr><td colspan="2">Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):</td></tr>
</table>

BMP Category G: Waste Generation, Disposal, and Recycling

BMP G-1: Minimize drill cuttings and all other investigation derived waste (including personal protection equipment) Examples: - Direct push or sonic drilling to reduce drill cuttings - Low-flow sampling or passive diffusion bags (if applicable) to reduce purge water - When possible place drill cuttings on-site rather than off-site disposal	**Date:** 1/26/12 ☒ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☐ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

There is little waste involved in this remedy. The main source of waste, iron sludge, would be reduced (eliminated?) if air stripper treatment at building 163 prior to discharge to the POTW is eliminated (RSE recommends evaluating potential for elimination of air stripping).

BMP G-2: Segregate excavated soil in pre-planned staging areas so that "clean" material can be deposited on-site and/or re-used rather than transported for off-site disposal	**Date:** 1/26/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

BMP Category G: Waste Generation, Disposal, and Recycling

BMP G-3: Consider on-site treatment and re-use of soil instead of off-site disposal
Examples:

- Land farming
- Above ground soil vapor extraction (SVE)

Date: 1/26/12

☐ Applicable

☐ Evaluated

☐ Practical

Implemented? ("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

BMP G-4: Minimize need to transport and dispose hazardous waste
Examples:

- Consider delisting listed hazardous waste if waste is not characteristically hazardous waste
- Segregate hazardous waste and non-hazardous waste

Date: 1/26/12

☐ Applicable

☐ Evaluated

☐ Practical

Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Do not believe sludge from stripper at Building 163 is "hazardous waste"

BMP Category G: Waste Generation, Disposal, and Recycling

BMP G-5: When possible avoid/minimize use of hazardous/toxic materials that may require special handling or disposal Examples: - Cleaning solutions - Pesticides - Disposable batteries (use rechargeable batteries) - MMRP projects: minimize Chemical Agent Contaminated Media (CACM) at RCWM sites.	**Date:** 1/26/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Not clear this applies.*	

BMP G-6: Recycle or re-use materials rather than disposing of them Examples: - Cardboard - Plastics - Concrete - Asphalt - Steel and other metals - Recovered oil/product - Mulch/compost - MMRP projects - recycle recovered Material Documented as Safe (MDAS) after inspection and certification that the remnants are free of explosive hazards	**Date:** 1/26/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Few materails and wastes are associated with the P&T.*	

BMP Category H: Land Use, Ecosystems, and Cultural Resources

BMP H-1: Minimize erosion and soil transport to surface water bodies

Examples:

- Quickly restore any vegetated areas disrupted by equipment or vehicles
- Institute appropriate erosion controls during excavation such as silt fencing

Date: 1/26/12

☐ Applicable

☐ Evaluated

☐ Practical

Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☒ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

BMP H-2: Minimize disturbances to land

Examples:

- Establish well-defined traffic patterns for onsite activities to minimize disturbed areas
- Consider non-intrusive investigation techniques (e.g., geophysical methods) to identify items like USTs and buried drums

Date: 1/26/12

☐ Applicable

☐ Evaluated

☐ Practical

Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☒ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

BMP Category H: Land Use, Ecosystems, and Cultural Resources

BMP H-3: Preserve/restore ecosystems to the extent possible Examples: - Limit the removal of trees and vegetation - Attempt to transplant disturbed shrubs and small trees to other locations - Use native species for re-vegetation - Retrieve dead trees during excavation and later reposition them as habitat snags - Select and place suitably sized and typed stones into water beds and banks - Undercut surface water banks in ways that mirror natural conditions - Cut back rather than remove trees, bushes, vegetation	**Date:** 1/26/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☒ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP):	

BMP H-4: Minimize drawdown of the water table in sensitive areas such as wetlands or areas subject to subsidence	**Date:** 1/26/12 ☒ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Not evaluated*	

<table>
<tr><td colspan="2">BMP H-5: Construct wells and other remedial process infrastructure (piping, buildings, etc.) to minimize restrictions to anticipated future use of the site</td><td>Date: 1/26/12
☐ Applicable
☐ Evaluated
☐ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A</td><td colspan="2">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
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<tr><td>Resources Conserved:
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☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Notes (including discussion of possible value of implementing the BMP):

Not evaluated.</td></tr>
</table>

<table>
<tr><td colspan="2">BMP H-6: Preserve/restore cultural resources to the extent possible
Examples:
- Protected lands such as wildlife refuges, national parks, and wilderness areas
- Culturally sensitive sites such as cemeteries, native burials, and archaeological finds
- Buildings or land parcels with historical significance</td><td>Date: 1/26/12
☐ Applicable
☐ Evaluated
☐ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A</td><td colspan="2">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
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☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Notes (including discussion of possible value of implementing the BMP):

Does not appear to apply.</td></tr>
</table>

BMP Category H: Land Use, Ecosystems, and Cultural Resources

<table>
<tr><td colspan="3">BMP H-7: Document sensitive ecological and cultural resources prior to initiating actions that might diminish or destroy those resources
Examples:
- Photodocument conditions prior to clearing brush
- MMRP projects: photodocument conditions prior to BIP</td><td>Date: 1/26/12
☐ Applicable
☐ Evaluated
☐ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social</td><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
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☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

Does not appear to apply to the P&T.</td></tr>
</table>

BMP Category I: Safety and Community

BMP I-1: Minimize and mitigate noise, light and odor disturbance during all phases of the remedial process, to the extent practicable	**Date:** 1/26/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *There are no major concerns over these types of disturbances for this project.*	

BMP I-2: Minimize dust during construction activities by spraying water or techniques such as laying biodegradable mats, tarps, or materials (already in EM385-1-1)	**Date:** 1/26/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☒ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☒ BMP otherwise required? If checked, required by: *EM385-1-1*
Notes (including discussion of possible value of implementing the BMP): *- don't appear to be any major construction activities anticipated*	

BMP Category I: Safety and Community

BMP I-3: Select transportation routes for trucks and heavy equipment that minimize impacts to residential areas to maximize safety and minimize noise and other aesthetic impacts	**Date:** 1/26/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < \$10,000 ☐ \$10,001 - \$50,000 ☐ \$50,001 - \$100,000 ☐ \$100,001 - \$500,000 ☐ > \$500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP):	

BMP I-4: Minimize drawdown of the water table in areas that could impact production rates at supply wells and/or irrigation wells	**Date:** 1/26/12 ☒ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < \$10,000 ☐ \$10,001 - \$50,000 ☐ \$50,001 - \$100,000 ☐ \$100,001 - \$500,000 ☐ > \$500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Several supply wells are located on the site, and production rates have presumably not been affected. Not really evaluated.*	

BMP Category I: Safety and Community

BMP I-5: Minimize amount of time that heavy machinery is needed to enhance safety		**Date:** 1/26/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A	
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000	
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☒ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:	
Notes (including discussion of possible value of implementing the BMP):		

BMP I-6: Minimize handling of dangerous chemicals by selecting alternate chemicals and/or engineering to minimize contact with chemicals (for MMRP projects, there is enhanced risk related to explosion potential and exposure to chemical agents (CA) and agent breakdown products (ABP) associated with RCWM responses)		**Date:** 1/26/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A	
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000	
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:	
Notes (including discussion of possible value of implementing the BMP): *Few chemicals used for this project.*		

BMP Category I: Safety and Community

<table>
<tr><td colspan="3">BMP I-7: Contribute to local economy when possible
Examples:
- Consider leasing local office space
- Purchase or lease equipment from local vendors
- Hire workers from local community</td><td>Date: 1/26/12
☒ Applicable
☐ Evaluated
☐ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social</td><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="2">Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

Not really evaluated.</td></tr>
</table>

BMP Category J: Other Site-Specific BMPs

BMP J-1:		**Date:** ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A	
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000	
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:	
Notes (including discussion of possible value of implementing the BMP):		

BMP J-2:		**Date:** ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A	
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000	
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:	
Notes (including discussion of possible value of implementing the BMP):		

Appendix B

Assumptions for SiteWise Input and Other Calculations, Lake City Army Ammunition Plant Pilot GSR Evaluation:

Current P&T Systems (Baseline)

Appendix B
Assumptions for SiteWise Input and Other Calculations
Lake City Army Ammunition Plant Pilot GSR Evaluation:

Current P&T Systems (Baseline)

SiteWise "RA_Baseline_NoFR_1" Directory

All calculations were performed on an annual basis (i.e., "per year"). This remedy includes the following:

- Combined stripper for 17AA and 17CC - ~15 HP blower and 15 HP transfer pump
- Stripper for 17BB - 10 HP blower and 15 HP transfer pump
- Stripper for 17EE - 10 HP blower and 15 HP transfer pump
- Stripper for 17JJ - 10 HP blower and 15 HP transfer pump
- Combined stripper for 17K and 17KK - 10 HP blower and 15 HP transfer pump

Note: range of HP on supply well pumps was designated 15-20 HP, so average of 17.5 HP was used for all supply well pumps

OU	Well Name	Location/Description	Pump (HP)	Typical Extraction Rate (gpm)	Air Stripper
1	17AA	Area 12, supply well also used for plume containment	15-20	~ 250	Shared
-	17CC	Supply well	15-20	~ 250	
-	17BB	Supply well	15-20	200	Stand-alone
-	17EE	Supply well	15-20	200	Stand-alone
-	17JJ	Supply well	15-20	200	Stand-alone
-	17K	Supply well	15-20	200	Shared
-	17KK	Supply well	15-20	200	
2	17R	Area 18 – between and just north of the two source areas	~15	~ 105	Bldg 163
2	17FF	Area 18 - north of toe of plume	~10	~ 70	Bldg 163
3	17S	Area 17D – at northern facility boundary	~15	~100	Bldg 163

- At supply wells 17K and 17KK, extraction occurs at only one of the two wells at a given time.

- A 25HP pump (there are two pumps, but only one operates at a time) moves the water from the EQ tank to the packed tower air stripper (45 ft packing depth), which uses a 15HP fan.

- From the air stripper water goes to a sump where it is transferred (two 25HP pumps, only one used at a time) to the Little Blue Valley Sewer District POTW.

- Air from the air stripper goes through a knockout tank to remove moisture, and then to a catalytic oxidizer (CATOX) unit with a 25 HP fan to draw air through. The CATOX is powered by natural gas (since the influent vapor concentrations are far too low to power the CATOX). The CATOX has a continuous gas analyzer.

The notes pertaining to SiteWise input are organized by the following tabs of the SiteWise input sheet:

- P&T System Operation – Uses “Remedial Action Operations” tab of the SiteWise input sheet

For each section of SiteWise, all the sections are listed, with pertinent information added only for those sections of the input sheet where data were added.

Other calculations done outside of SiteWise are then presented. These include the following:

- % of total energy from renewable resources
- Hazardous air pollutants
- Refined material use
- Unrefined material use
- Tons of non-hazardous waste
- Tons of hazardous waste
- Risks to on-site works and from transportation
- Heavy truck trips through residential areas

Additional tables are attached which show how SiteWise outputs were split into “direct” and “indirect” energy use and greenhouse gas emissions. For definitions of direct and indirect energy use and emissions, please refer to section 2.2.2 of the evaluation report.

Costs for this remedy are difficult to assess because the much of the work is being performed under a performance-based contract. Consistent with the previous RSE, this GSR evaluation is done on a per year basis and not on a life-cycle basis. Therefore, there is no up-front cost and no discounted cost for the life-cycle. The annual cost estimate of $824,000 per year that was provided to the RSE team is just for operation of the Building 163 treatment system, and does not include the costs for treatment of the water supply wells or any of the in-situ remedies.

Current P&T Systems (Baseline) - Operation

Scope of Work

- 6 pumps, 17.5 HP each (extraction from supply wells 17 AA, CC, EE, BB, JJ, KK/K). Note that extraction (electricity and water use) at these wells is not included in the footprint analysis because they provide water supply after treatment (i.e., not part of the remedy footprint).
- 1 pump, 10 HP (extraction well 17FF)
- 2 pumps, 25 HP each (pump water up air stripper (1) and transport treated water from Bldg 163 to POTW, each place has 2 pumps but only one pump at each place is operated at a time)
- 7 pumps, 15 HP each (transfer pumps on 5 individual air strippers (AA/CC, EE, BB, JJ, KK/K), extraction on 2 wells (17S and 17R))
- 4 blowers, 10 HP each (blowers on individual air strippers on supply wells 17 EE, BB, JJ, KK/K)
- 2 blowers, 15 HP each (one on air stripper from supply wells 17 AA/CC, one on Bldg 163 air stripper)
- 1 blower, 25 HP for CATOX in Bldg 163

Building 163 heater: 400 m (thousand) cubic ft natural/Mo to heat for 5 mo or 2000 MCF natural gas X 1.028 MM (million) BTU/MCF = 2056 MMBtu.

Catalytic oxidizer modeled using catalytic oxidizer package in SiteWise. The energy use for a year was 900 m(thousand)CF/mo X 12 mo X 1.028 MM (million)BTU/mCF = 1.08 E04 MMBtu. Enter parameters in SiteWise that replicate that energy use. Per the SiteWise Version 2.0 input guide, the 25 HP blower for the CATOX is included separately, as listed above.

Water usage (water extracted from the aquifer removed for other use as a resource) – using 2011rates at wells treated at Building 163 (other wells are used for water supply after treatment and therefore are not counted here), assigned as 105 gpm + 70 gpm + 100 gpm = 275 gpm * 1440 min/day * 365 day/yr = 144540000 gallons in a year.

Current P&T Systems (Baseline) - Operation

<u>Input into "Remedial Action Operations" tab of SiteWise Input Sheet.xls</u>

- Baseline Information
  - Remedial Action Operations Cost and Duration
    - Total remedial action operations cost ($) – leave blank
    - Duration of remedial action operations (unit time) – 1 yr for this GSR evaluation

- Material Production
  - Well Materials
  - Treatment Chemicals & Materials
  - Treatment Media
  - Construction Materials
  - Well Decommissioning
  - Bulk Material Quantities

- Transportation
  - Personnel Transportation – Road
  - Personnel Transportation – Air
  - Personnel Transportation – Rail
  - Equipment Transportation – Road
  - Equipment Transportation – Air
  - Equipment Transportation – Rail
  - Equipment Transportation – Water

- Equipment Use
  - Earthwork
  - Drilling
  - Trenching
  - Pump Operation
    - Pump 1 – Extraction from well 17 FF. Select Method 3. Grid region "SPNO" should be pre-selected; if not, go to Site Info tab and select. 1 pump at 10 HP operating continuously (24 hours per day * 365 days per year).
    - Pump 2 – 1 to pump water up air stripper and 2 (only 1 operated at a time) to transport treated water from Bldg 163 to POTW. Select Method 3. 2 pumps at 25 HP operating continuously (24 hours per day * 365 days per year).
    - Pump 3 – Transfer pumps on 5 individual air strippers and 2 extraction pumps on 17S and 17R. Select Method 3. 7 pumps at 15 HP operating continuously (24 hours per day * 365 days per year).

  - Diesel and Gasoline Pumps
  - Blower, Compressor, Mixer, and Other Equipment
    - Equipment 1 – Blowers on individual air strippers on supply wells 17 EE, BB, JJ, and KK/K. Select Method 1. 4 blowers at 10 HP operating continuously (24 hours per day * 365 days per year).
    - Equipment 2 – 1 blower on combined air stripper for supply wells 17 AA/CC and one blower on BLDG 163 air stripper. Select Method 1. 2 blowers at 15 HP operating continuously (24 hours per day * 365 days per year).

        - Equipment 3 - 1 blower CATOX for BLDG 163 air stripper. Select Method 1. 1 blowers at 25 HP operating continuously (24 hours per day * 365 days per year).
    - Generators
    - Agricultural Equipment
    - Capping Equipment
    - Mixing Equipment
    - Internal Combustion Engines
    - Other Fueled Equipment
        - Fuel 1 – Natural gas use for building 163 heater. 400 m (thousand) cubic ft natural/month for 5 months or 2000 MCF natural gas * 1000 to convert MCF to SCF = 2000000 SCF natural gas.
    - Operator Labor
    - Laboratory Analysis
    - Other Known Onsite Activities

- Residual Handling
    - Residue Disposal/Recycling
    - Landfill Operations
    - Thermal/Catalytic Oxidizers
        - Oxidizer 1 – Catalytic oxidizer at Bldg 163. Input parameters started with 750 F temp and 6000 SCF/min and were iterated until the energy use for a year was obtained. The energy use for a year was 900 m(thousand)CF/mo X 12 mo X 1.028 MMBtu/mCF = 1.08 E04 MMBtu. The input parameters that yielded this electrical usage were 750F operating temp, continuous operation (8760 hrs/year), 6 ppmV contaminant concentration, and 1350 SCF/min flow.

- Resource Consumption
    - Water Consumption
    - Onsite Land and Water Resource Consumption
        - Volume of groundwater or surface water lost (gal) – (water extracted from the aquifer removed for other use as a resource) – using 2011rates at wells treated at Building 163 (other wells are used for water supply after treatment and therefore are not counted here), assigned as 105 gpm + 70 gpm + 100 gpm = 275 gpm * 1440 min/day * 365 day/yr = 144540000 gallons in a year.

Once SiteWise input is complete, go to "SiteWise_Input Sheet " for overall project and enter information (including Alternative File Name "Baseline"). Then go to "Generate Alternative" tab and click button labeled "Click to generate alternative using previously entered alternative name". Copies of the input and output summary sheets for this alternative are now located in the directory titled "RA_Baseline _NoFR_1". To store the "Remedial Action Opeartions.xls" calculation sheet showing detailed calculations, open it in the overall SiteWise project directory when the appropriate input sheet is open, then do a "save as" to put it in the directory for this alternative using a name that indicates "will not update". Then open that file and do "data->edit links" and break the links. If the input sheet for this alternative ever changes, then this calculation sheet needs to be re-saved.

To edit input parameters for this alternative, you must go back to the ORIGINAL SiteWise input sheet and import this alternative using the "Do you want to reload a previously saved remedial alternative

in the SiteWise input sheet?" field on the "Site Info" tab. After making necessary changes to the input sheet, re-export the alternative by going to the "Generate Alternative" tab and clicking the button labeled "Click to replace an existing alternative with the same name". Update saved calculation sheets as described above.

Other Supporting Calculations:
Current P&T Systems (Baseline)

% of Total Energy Usage from Renewable Resources

- Negligible. No on-site renewable energy generation was noted, and eGRID says that for this region of the country only 0.76% of the electricity is from renewable sources. Since not all of the energy use on this site is from electricity, the percentage would be even smaller.

Hazardous Air Pollutants

- None identified

.

Refined Materials Use

- Not quantified. The RSE identified use of air stripper media, CATOX calibration gases, and maintenance parts and supplies for pumps, pipes, etc. , but quantities were not identified.

Unrefined Materials Use

- None identified

Tons of Non-Hazardous Waste

- Not quantified. The RSE identified that plastic rings from the Building 163 stripper go to a landfill, as does iron oxide sludge from bottom of that stripper. These wastes are mixed with other wastes from the Installation prior to disposal. These wastes were not quantified in the RSE.

Tons of Hazardous Waste

- None identified

Risks to On-Site Workers and from Transportation

- None identified

Heavy Truck Trips through Residential Areas

- None identified

GSR Team Calculations to Split Energy Results from SiteWise into "Direct" and "Indirect"
Current P&T Systems (Baseline)

phase	Reported by SiteWise		Assigned by GSR Team from SiteWise Output			Added by GSR Team	Total Calculated by GSR Team
			Scope 1 (direct)	Scope 2 (indirect)	Scope 3 (indirect)	Scope 3 (indirect)	
	activity	energy used (MMBTU)	energy used (MMBTU)	energy used (MMBTU)	energy used (MMBTU)	energy used (MMBTU)	
P&T System Operation (remedial action operations tab)	Consumables	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Equipment	0.00	0.00	0.00	0.00	0.00	0.00
	Equipment Use and Misc	19527.22	7322.78	11766.01	438.42	0.00	19527.22
	Residual Handling	10855.56	8434.77	0.00	2420.79	0.00	10855.56
	Sub-Total	30382.78	15757.55	11766.01	2859.21	0.00	30382.78
total		30382.78	15757.55	11766.01	2859.21	0.00	30382.78

Note: Electricity use reported by SiteWise Version 2.0 in units of kWh is "Direct Scope 1", meaning it is energy consumed at the location of the project. However, energy use associated with electricity reported by SiteWise in units of MMBtu is a life-cycle value which also includes a factor to account for energy used elsewhere required to generate the electricity ("Indirect Scope 2"). Here, 33% of the life-cycle value reported by SiteWise is considered to be "Scope 1" on-site energy use, and 67% is considered to be "Scope 2" energy used in electricity generation.

SiteWise Version 2.0 uses a natural gas energy value from U.S. Department of Energy, Argonne National Laboratory, Transportation Technology R&D Center, GREET 1.8d.1, Fuel-Cycle model, 2010. This version of the GREET model reports that for Compressed Natural Gas (NA), approximately 22.3% of GHG emissions are upstream emissions (scope 3) and 77.7% are tailpipe emissions (scope 1). For this analysis, it is assumed that energy is used in these same proportions, and therefore the energy use reported by SiteWise is split between scope 3 and scope 1 in these ratios.

GSR Team Calculations to Split GHG Results from SiteWise into "Direct" and "Indirect"
Current P&T Systems (Baseline)

phase	Reported by SiteWise		Assigned by GSR Team from SiteWise Output			Added by GSR Team	Total Calculated by GSR Team
			Scope 1 (direct)	Scope 2 (indirect)	Scope 3 (indirect)	Scope 3 (indirect)	
	activity	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	
P&T System Operation (remedial action operations tab)	Consumables	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Equipment	0.00	0.00	0.00	0.00	0.00	0.00
	Equipment Use and Misc	1757.06	125.81	1595.15	36.11	0.00	1757.06
	Residual Handling	894.03	694.66	0.00	199.37	0.00	894.03
	Sub-Total	2651.09	820.47	1595.15	235.48	0.00	2651.09
Total		2651.09	820.47	1595.15	235.48	0.00	2651.09

Note: CO2e reported by SiteWise Version 2.0 for electricity use is all associated with generation of the electricity ("Indirect Scope 2").
SiteWise Version 2.0 uses natural gas emission factors from U.S. Department of Energy, Argonne National Laboratory, Transportation Technology R&D Center, GREET 1.8d.1, Fuel-Cycle model, 2010. This version of the GREET model reports that for Compressed Natural Gas (NA), approximately 22.3% of GHG emissions are upstream emissions (Scope 3) and 77.7% are tailpipe emissions (Scope 1). For this analysis, the GHG emissions reported by SiteWise are split between Scope 3 and Scope 1 in these ratios.

Appendix C

Supporting Information and/or Calculations for Footprinting of Other P&T Alternatives

Appendix C-1

Alternative 1 - Eliminate CATOX at Building 163

Appendix C1
Assumptions for SiteWise Input and Other Calculations
Lake City Army Ammunition Plant Pilot GSR Evaluation:

Alternative 1 - Eliminate CATOX at Building 163

SiteWise "RA_Alternative1_NoFR_1" Directory

All calculations were performed on an annual basis (i.e., "per year"). In this alternative, treatment of air emissions via CATOX is eliminated from the system. This remedy alternative includes the following:

- Combined stripper for 17AA and 17CC - ~15 HP blower and 15 HP transfer pump
- Stripper for 17BB - 10 HP blower and 15 HP transfer pump
- Stripper for 17EE - 10 HP blower and 15 HP transfer pump
- Stripper for 17JJ - 10 HP blower and 15 HP transfer pump
- Combined stripper for 17K and 17KK - 10 HP blower and 15 HP transfer pump

Note: range of HP on supply well pumps was designated 15-20 HP, so average of 17.5 HP was used for all supply well pumps

OU	Well Name	Location/Description	Pump (HP)	Typical Extraction Rate (gpm)	Air Stripper
1	17AA	Area 12, supply well also used for plume containment	15-20	~ 250	Shared
-	17CC	Supply well	15-20	~ 250	
-	17BB	Supply well	15-20	200	Stand-alone
-	17EE	Supply well	15-20	200	Stand-alone
-	17JJ	Supply well	15-20	200	Stand-alone
-	17K	Supply well	15-20	200	Shared
-	17KK	Supply well	15-20	200	
2	17R	Area 18 – between and just north of the two source areas	~15	~ 105	Bldg 163
2	17FF	Area 18 - north of toe of plume	~10	~ 70	Bldg 163
3	17S	Area 17D – at northern facility boundary	~15	~100	Bldg 163

- At supply wells 17K and 17KK, extraction occurs at only one of the two wells at a given time.

- A 25HP pump (there are two pumps, but only one operates at a time) moves the water from the EQ tank to the packed tower air stripper (45 ft packing depth), which uses a 15HP fan.

Alternative 1 – Overview

- From the air stripper water goes to a sump where it is transferred (two 25HP pumps, only one used at a time) to the Little Blue Valley Sewer District POTW.

The notes pertaining to SiteWise input are organized by the following tabs of the SiteWise input sheet:

- P&T System Operation – Uses "Remedial Action Operations" tab of the SiteWise input sheet

For each section of SiteWise, all the sections are listed, with pertinent information added only for those sections of the input sheet where data were added.

Other calculations done outside of SiteWise are then presented. These include the following:

- % of total energy from renewable resources
- Hazardous air pollutants
- Refined material use
- Unrefined material use
- Tons of non-hazardous waste
- Tons of hazardous waste
- Risks to on-site works and from transportation
- Heavy truck trips through residential areas

Additional tables are attached which show how SiteWise outputs were split into "direct" and "indirect" energy use and greenhouse gas emissions. For definitions of direct and indirect energy use and emissions, please refer to section 2.2.2 of the evaluation report.

There should be no significant cost to implement this change and potential cost savings of approximately $76,000/yr include the following:

- Annual savings of approximately $54,000 for natural gas

    - 900 mcf/mnth * 12 months/yr * ~$5/mcf = ~ $54,000/yr

- Annual savings of approximately $11,600 for elimination of the 25 HP blower assuming 0.85 load and 0.85 efficiency, a conversion factor of 0.746 kW/HP, 95% uptime, and an estimated electricity rate of $0.07/kWh

    - 25 HP * 0.85/0.85 * 0.746 * 24hrs/day * 365 days/yr * $0.07/kWh = ~$11,400/yr

- Annual savings of approximately $10,300 per year for the CATOX project management contract

Alternative 1 – Operation

<u>*Scope of Work*</u>

- 6 pumps, 17.5 HP each (extraction from supply wells 17 AA, CC, EE, BB, JJ, KK/K). Note that extraction (electricity and water use) at these wells is not included in the footprint analysis because they provide water supply after treatment (i.e., not part of the remedy footprint).
- 1 pump, 10 HP (extraction well 17FF)
- 2 pumps, 25 HP each (pump water up air stripper (1) and transport treated water from Bldg 163 to POTW (2, operated 1 at a time))
- 7 pumps, 15 HP each (transfer pumps on 5 individual air strippers (AA/CC, EE, BB, JJ, KK/K), extraction on 2 wells (17S and 17R))
- 4 blowers, 10 HP each (blowers on individual air strippers on supply wells 17 EE, BB, JJ, KK/K)
- 2 blowers, 15 HP each (one on air stripper from supply wells 17 AA/CC, one on Bldg 163 air stripper)

Building 163 heater: 400 m (thousand) cubic ft natural/Mo to heat for 5 mo or 2000 MCF natural gas X 1.028 MM (million) BTU/MCF = 2056 MMBtu.

Water usage (water extracted from the aquifer removed for other use as a resource) – using 2011rates at wells treated at Building 163 (other wells are used for water supply after treatment and therefore are not counted here), assigned as 105 gpm + 70 gpm + 100 gpm = 275 gpm * 1440 min/day * 365 day/yr = 144540000 gallons in a year.

Alternative 1 – Operation

<u>Input into “Remedial Action Operations” tab of SiteWise Input Sheet.xls</u>

- Baseline Information
    - Remedial Action Operations Cost and Duration
        - Total remedial action operations cost ($) – leave blank
        - Duration of remedial action operations (unit time) – 1 yr for this GSR evaluation

- Material Production
    - Well Materials
    - Treatment Chemicals & Materials
    - Treatment Media
    - Construction Materials
    - Well Decommissioning
    - Bulk Material Quantities

- Transportation
    - Personnel Transportation – Road
    - Personnel Transportation – Air
    - Personnel Transportation – Rail
    - Equipment Transportation – Road
    - Equipment Transportation – Air
    - Equipment Transportation – Rail
    - Equipment Transportation – Water

- Equipment Use
    - Earthwork
    - Drilling
    - Trenching
    - Pump Operation
        - Pump 1 – Extraction from well 17 FF. Select Method 3. Grid region “SPNO” should be pre-selected; if not, go to Site Info tab and select. 1 pump at 10 HP operating continuously (24 hours per day * 365 days per year).
        - Pump 2 – 1 to pump water up air stripper and 2 (only 1 operated at a time) to transport treated water from Bldg 163 to POTW. Select Method 3. 2 pumps at 25 HP operating continuously (24 hours per day * 365 days per year).
        - Pump 3 – Transfer pumps on 5 individual air strippers and 2 extraction pumps on 17S and 17R. Select Method 3. 7 pumps at 15 HP operating continuously (24 hours per day * 365 days per year).

    - Diesel and Gasoline Pumps
    - Blower, Compressor, Mixer, and Other Equipment
        - Equipment 1 – Blowers on individual air strippers on supply wells 17 EE, BB, JJ, and KK/K. Select Method 1. 4 blowers at 10 HP operating continuously (24 hours per day * 365 days per year).
        - Equipment 2 – 1 blower on combined air stripper for supply wells 17 AA/CC and one blower on BLDG 163 air stripper. Select Method 1. 2 blowers at 15 HP operating continuously (24 hours per day * 365 days per year).

Alternative 1 – Operation

- Generators
- Agricultural Equipment
- Capping Equipment
- Mixing Equipment
- Internal Combustion Engines
- Other Fueled Equipment
  - Fuel 1 – Natural gas use for building 163 heater. 400 m (thousand) cubic ft natural/month for 5 months or 2000 MCF natural gas * 1000 to convert MCF to SCF = 2000000 SCF natural gas.
- Operator Labor
- Laboratory Analysis
- Other Known Onsite Activities

- Residual Handling
  - Residue Disposal/Recycling
  - Landfill Operations
  - Thermal/Catalytic Oxidizers

- Resource Consumption
  - Water Consumption
  - Onsite Land and Water Resource Consumption
    - Volume of groundwater or surface water lost (gal) – (water extracted from the aquifer removed for other use as a resource) – using 2011rates at wells treated at Building 163 (other wells are used for water supply after treatment and therefore are not counted here), assigned as 105 gpm + 70 gpm + 100 gpm = 275 gpm * 1440 min/day * 365 day/yr = 144540000 gallons in a year.

Once SiteWise input is complete, go to "SiteWise_Input Sheet " for overall project and enter information (including Alternative File Name "Alternative1"). Then go to "Generate Alternative" tab and click button labeled "Click to generate alternative using previously entered alternative name". Copies of the input and output summary sheets for this alternative are now located in the directory titled "RA_Alternative1 _NoFR_1". To store the "Remedial Action Opeartions.xls" calculation sheet showing detailed calculations, open it in the overall SiteWise project directory when the appropriate input sheet is open, then do a "save as" to put it in the directory for this alternative using a name that indicates "will not update". Then open that file and do "data->edit links" and break the links. If the input sheet for this alternative ever changes, then this calculation sheet needs to be re-saved.

To edit input parameters for this alternative, you must go back to the ORIGINAL SiteWise input sheet and import this alternative using the "Do you want to reload a previously saved remedial alternative in the SiteWise input sheet?" field on the "Site Info" tab. After making necessary changes to the input sheet, re-export the alternative by going to the "Generate Alternative" tab and clicking the button labeled "Click to replace an existing alternative with the same name". Update saved calculation sheets as described above.

Other Supporting Calculations
Alternative 1 - Eliminate CATOX at Building 163

% of Total Energy Usage from Renewable Resources

- Negligible. No on-site renewable energy generation was noted, and eGRID says that for this region of the country only 0.76% of the electricity is from renewable sources. Since not all of the energy use on this site is from electricity, the percentage would be even smaller.

Hazardous Air Pollutants

- None identified

.

Refined Materials Use

- Not quantified. The RSE identified use of air stripper media, CATOX calibration gases, and maintenance parts and supplies for pumps, pipes, etc. , but quantities were not identified. This alternative would eliminate the use of CATOX calibration gases.

Unrefined Materials Use

- None identified

Tons of Non-Hazardous Waste

- Not quantified. The RSE identified that plastic rings from the Building 163 stripper go to a landfill, as does iron oxide sludge from bottom of that stripper. These wastes are mixed with other wastes from the Installation prior to disposal. These wastes were not quantified in the RSE.

Tons of Hazardous Waste

- None identified

Risks to On-Site Workers and from Transportation

- None identified

Heavy Truck Trips through Residential Areas

- None identified

GSR Team Calculations to Split Energy Results from SiteWise into "Direct" and "Indirect"
Alternative 1 - Eliminate CATOX at Building 163

			Assigned by GSR Team from SiteWise Output			Added by GSR Team	
	Reported by SiteWise		Scope 1 (direct)	Scope 2 (indirect)	Scope 3 (indirect)	Scope 3 (indirect)	
phase	activity	energy used (MMBTU)	energy used (MMBTU)	energy used (MMBTU)	energy used (MMBTU)	energy used (MMBTU)	Total Calculated by GSR Team
P&T System Operation (remedial action operations tab)	Consumables	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Equipment	0.00	0.00	0.00	0.00	0.00	0.00
	Equipment Use and Misc	17838.64	6765.55	10634.67	438.42	0.00	17838.64
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-Total	17838.64	6765.55	10634.67	438.42	0.00	17838.64
total		17838.64	6765.55	10634.67	438.42	0.00	17838.64

Note: Electricity use reported by SiteWise Version 2.0 in units of kWh is "Direct Scope 1", meaning it is energy consumed at the location of the project. However, energy use associated with electricity reported by SiteWise in units of MMBtu is a life-cycle value which also includes a factor to account for energy used elsewhere required to generate the electricity ("Indirect Scope 2"). Here, 33% of the life-cycle value reported by SiteWise is considered to be "Scope 1" on-site energy use, and 67% is considered to be "Scope 2" energy used in electricity generation.

SiteWise Version 2.0 uses a natural gas energy value from U.S. Department of Energy, Argonne National Laboratory, Transportation Technology R&D Center, GREET 1.8d.1, Fuel-Cycle model, 2010. This version of the GREET model reports that for Compressed Natural Gas (NA), approximately 22.3% of GHG emissions are upstream emissions (scope 3) and 77.7% are tailpipe emissions (scope 1). For this analysis, it is assumed that energy is used in these same proportions, and therefore the energy use reported by SiteWise is split between scope 3 and scope 1 in these ratios.

GSR Team Calculations to Split GHG Results from SiteWise into "Direct" and "Indirect"
Alternative 1 - Eliminate CATOX at Building 163

phase	Reported by SiteWise		Assigned by GSR Team from SiteWise Output			Added by GSR Team	Total Calculated by GSR Team
			Scope 1 (direct)	Scope 2 (indirect)	Scope 3 (indirect)	Scope 3 (indirect)	
	activity	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	
P&T System Operation (remedial action operations tab)	Consumables	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Equipment	0.00	0.00	0.00	0.00	0.00	0.00
	Equipment Use and Misc	1603.68	125.81	1441.77	36.11	0.00	1603.68
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-Total	1603.68	125.81	1441.77	36.11	0.00	1603.68
Total		1603.68	125.81	1441.77	36.11	0.00	1603.68

Note: CO2e reported by SiteWise Version 2.0 for electricity use is all associated with generation of the electricity ("Indirect Scope 2").
SiteWise Version 2.0 uses natural gas emission factors from U.S. Department of Energy, Argonne National Laboratory, Transportation Technology R&D Center, GREET 1.8d.1, Fuel-Cycle model, 2010. This version of the GREET model reports that for Compressed Natural Gas (NA), approximately 22.3% of GHG emissions are upstream emissions (Scope 3) and 77.7% are tailpipe emissions (Scope 1). For this analysis, the GHG emissions reported by SiteWise are split between Scope 3 and Scope 1 in these ratios.

Appendix C-2

Alternative 2 - Eliminate Individual Water Supply Well Strippers

Appendix C2
Assumptions for SiteWise Input and Other Calculations
Lake City Army Ammunition Plant Pilot GSR Evaluation:

Alternative 2 - Eliminate Individual Water Supply Well Strippers

SiteWise "RA_ Alternative2_NoFR_1" Directory

All calculations were performed on an annual basis (i.e., "per year").

This alternative involves cutting out air strippers currently used on individual supply wells and instead sending the combined flow directly to the central treatment plant. It assumes a 30 HP blower added to the current plant for additional treatment capacity. In this alternative, extraction pumps from wells would pump directly to the central treatment plant, eliminating the following transfer pumps and blowers associated with individual strippers:

- Combined stripper for 17AA and 17CC - ~15 HP blower and 15 HP transfer pump
- Stripper for 17BB - 10 HP blower and 15 HP transfer pump
- Stripper for 17EE - 10 HP blower and 15 HP transfer pump
- Stripper for 17JJ - 10 HP blower and 15 HP transfer pump
- Combined stripper for 17K and 17KK - 10 HP blower and 15 HP transfer pump

This system would still include the supply well pumps used for extraction:

OU	Well Name	Location/Description	Pump (HP)	Typical Extraction Rate (gpm)
1	17AA	Area 12, supply well also used for plume containment	15-20	~ 250
-	17CC	Supply well	15-20	~ 250
-	17BB	Supply well	15-20	200
-	17EE	Supply well	15-20	200
-	17JJ	Supply well	15-20	200
-	17K	Supply well	15-20	200
-	17KK	Supply well	15-20	200
2	17R	Area 18 – between and just north of the two source areas	~15	~ 105
2	17FF	Area 18 - north of toe of plume	~10	~ 70
3	17S	Area 17D – at northern facility boundary	~15	~100

Alternative 2 – Overview

- At supply wells 17K and 17KK, extraction occurs at only one of the two wells at a given time.

- A 25HP pump (there are two pumps, but only one operates at a time) moves the water from the EQ tank to the packed tower air stripper (45 ft packing depth), which uses a 15HP fan.

- From the air stripper water goes to a sump where it is transferred (two 25HP pumps, only one used at a time) to the Little Blue Valley Sewer District POTW.

- Air from the air stripper goes through a knockout tank to remove moisture, and then to a catalytic oxidizer (CATOX) unit with a 25 HP fan to draw air through. The CATOX is powered by natural gas (since the influent vapor concentrations are far too low to power the CATOX). The CATOX has a continuous gas analyzer.

The notes pertaining to SiteWise input are organized by the following tabs of the SiteWise input sheet:

- P&T System Operation – Uses "Remedial Action Operations" tab of the SiteWise input sheet

For each section of SiteWise, all the sections are listed, with pertinent information added only for those sections of the input sheet where data were added.

Other calculations done outside of SiteWise are then presented. These include the following:

- % of total energy from renewable resources
- Hazardous air pollutants
- Refined material use
- Unrefined material use
- Tons of non-hazardous waste
- Tons of hazardous waste
- Risks to on-site works and from transportation
- Heavy truck trips through residential areas

Additional tables are attached which show how SiteWise outputs were split into "direct" and "indirect" energy use and greenhouse gas emissions. For definitions of direct and indirect energy use and emissions, please refer to section 2.2.2 of the evaluation report.

An estimate of the cost impacts is as follows. This represents 130 HP eliminated. The RSE assumed that upgrades at the IWTP will require the addition of approximately a 30 HP blower (this cannot be refined at this time due to lack of information for flow rates and concentrations). In net, approximately 100 HP would be saved. This translates to an annual savings of approximately $46,000 for elimination of a 100 HP blower assuming 0.85 load and 0.85 efficiency, a conversion factor of 0.746 kW/HP, and an estimated electricity rate of $0.07/kWh.

100 HP * 0.85/0.85 * 0.746 * 24hrs/day * 365 days/yr * $0.07/kWh = ~$46,000/yr

There will likely be some additional savings in labor associated with maintaining these strippers, but that has not been quantified.

Alternative 2 – Overview

There will presumably be some up-front costs (including design) to implement this recommendation. The RSE estimated that a centralized solution may cost on the order of $200,000 up-front to design and implement. Assuming a $200,000 up-front cost and savings of approximately $46,000 per year, the payback period would be less than 5 years.

Alternative 2 - Operation

Scope of Work

- 6 pumps, 17.5 HP each (extraction from supply wells 17 AA, CC, EE, BB, JJ, KK/K). Note that extraction (electricity and water use) at these wells is not included in the footprint analysis because they provide water supply after treatment (i.e., not part of the remedy footprint).
- 1 pump, 10 HP (extraction well 17FF)
- 2 pumps, 25 HP each (pump water up air stripper (1) and transport treated water from Bldg 163 to POTW (2, operated 1 at a time))
- 2 pumps, 15 HP each (extraction on 2 wells (17S and 17R))
- 4 blowers, 10 HP each (blowers on individual air strippers on supply wells 17 EE, BB, JJ, KK/K)
- 1 blower, 15 HP (blower on Bldg 163 air stripper)
- 1 blower, 25 HP for CATOX in Bldg 163
- 1 blower, 30 HP (blower added to on-site treatment plant for additional treatment of supply well water no longer being pretreated)

Building 163 heater: 400 m (thousand) cubic ft natural/Mo to heat for 5 mo or 2000 MCF natural gas X 1.028 MM (million) BTU/MCF = 2056 MMBtu.

Catalytic oxidizer modeled using catalytic oxidizer package in SiteWise. The energy use for a year was 900 m(thousand)CF/mo X 12 mo X 1.028 MM (million)BTU/mCF = 1.08 E04 MMBtu. Enter parameters in SiteWise that replicate that energy use. Per the SiteWise Version 2.0 input guide, the 25 HP blower for the CATOX is included separately, as listed above.

Water usage (water extracted from the aquifer removed for other use as a resource) – using 2011rates at wells treated at Building 163 (other wells are used for water supply after treatment and therefore are not counted here), assigned as 105 gpm + 70 gpm + 100 gpm = 275 gpm * 1440 min/day * 365 day/yr = 144540000 gallons in a year.

Alternative 2 - Operation

<u>Input into “Remedial Action Operations” tab of SiteWise Input Sheet.xls</u>

- Baseline Information
    - Remedial Action Operations Cost and Duration
        - Total remedial action operations cost ($) – leave blank
        - Duration of remedial action operations (unit time) – 1 yr for this GSR evaluation

- Material Production
    - Well Materials
    - Treatment Chemicals & Materials
    - Treatment Media
    - Construction Materials
    - Well Decommissioning
    - Bulk Material Quantities

- Transportation
    - Personnel Transportation – Road
    - Personnel Transportation – Air
    - Personnel Transportation – Rail
    - Equipment Transportation – Road
    - Equipment Transportation – Air
    - Equipment Transportation – Rail
    - Equipment Transportation – Water

- Equipment Use
    - Earthwork
    - Drilling
    - Trenching
    - Pump Operation
        - Pump 1 – Extraction from well 17FF. Select Method 3. Grid region “SPNO” should be pre-selected; if not, go to Site Info tab and select. 1 pump at 10 HP operating continuously (24 hours per day * 365 days per year).
        - Pump 2 – 1 to pump water up air stripper and 2 (only 1 operated at a time) to transport treated water from Bldg 163 to POTW. Select Method 3. 2 pumps at 25 HP operating continuously (24 hours per day * 365 days per year).
        - Pump 3 – 2 extraction pumps on 17S and 17R. Select Method 3. 2 pumps at 15 HP operating continuously (24 hours per day * 365 days per year).

    - Diesel and Gasoline Pumps
    - Blower, Compressor, Mixer, and Other Equipment
        - Equipment 1 – 1 blower on BLDG 163 air stripper. Select Method 1. 1 blower at 15 HP operating continuously (24 hours per day * 365 days per year).
        - Equipment 2 – 1 blower added to on-site treatment plant for additional treatment. Select Method 1. 1 blower at 30 HP operating continuously (24 hours per day * 365 days per year).
        - Equipment 3 - 1 blower CATOX for BLDG 163 air stripper. Select Method 1. 1 blowers at 25 HP operating continuously (24 hours per day * 365 days per year).
    - Generators

Alternative 2 - Operation

- Agricultural Equipment
- Capping Equipment
- Mixing Equipment
- Internal Combustion Engines
- Other Fueled Equipment
  - Fuel 1 – Natural gas use for building 163 heater. 400 m (thousand) cubic ft natural/month for 5 months or 2000 MCF natural gas * 1000 to convert MCF to SCF = 2000000 SCF natural gas.
- Operator Labor
- Laboratory Analysis
- Other Known Onsite Activities

- Residual Handling
  - Residue Disposal/Recycling
  - Landfill Operations
  - Thermal/Catalytic Oxidizers
    - Oxidizer 1 – Catalytic oxidizer at Bldg 163. Input parameters started with 750 F temp and 6000 SCF/min and were iterated until the energy use for a year was obtained. The energy use for a year was 900 m(thousand)CF/mo X 12 mo X 1.028 MMBtu/mCF = 1.08 E04 MMBtu. The input parameters that yielded this electrical usage were 750F operating temp, continuous operation (8760 hrs/year), 6 ppmV contaminant concentration, and 1350 SCF/min flow.

- Resource Consumption
  - Water Consumption
  - Onsite Land and Water Resource Consumption
    - Volume of groundwater or surface water lost (gal) – (water extracted from the aquifer removed for other use as a resource) – using 2011rates at wells treated at Building 163 (other wells are used for water supply after treatment and therefore are not counted here), assigned as 105 gpm + 70 gpm + 100 gpm = 275 gpm * 1440 min/day * 365 day/yr = 144540000 gallons in a year.

Once SiteWise input is complete, go to "SiteWise_Input Sheet " for overall project and enter information (including Alternative File Name "Alternative2"). Then go to "Generate Alternative" tab and click button labeled "Click to generate alternative using previously entered alternative name". Copies of the input and output summary sheets for this alternative are now located in the directory titled "RA_Alternative2 _NoFR_1". To store the "Remedial Action Opeartions.xls" calculation sheet showing detailed calculations, open it in the overall SiteWise project directory when the appropriate input sheet is open, then do a "save as" to put it in the directory for this alternative using a name that indicates "will not update". Then open that file and do "data->edit links" and break the links. If the input sheet for this alternative ever changes, then this calculation sheet needs to be re-saved.

To edit input parameters for this alternative, you must go back to the ORIGINAL SiteWise input sheet and import this alternative using the "Do you want to reload a previously saved remedial alternative in the SiteWise input sheet?" field on the "Site Info" tab. After making necessary changes to the input sheet, re-export the alternative by going to the "Generate Alternative" tab and clicking the button

labeled "Click to replace an existing alternative with the same name". Update saved calculation sheets as described above.

Other Supporting Calculations:
Alternative 2 - Eliminate Individual Water Supply Well Strippers

% of Total Energy Usage from Renewable Resources

- Negligible. No on-site renewable energy generation was noted, and eGRID says that for this region of the country only 0.76% of the electricity is from renewable sources. Since not all of the energy use on this site is from electricity, the percentage would be even smaller.

Hazardous Air Pollutants

- None identified

.

Refined Materials Use

- Not quantified. The RSE identified use of air stripper media, CATOX calibration gases, and maintenance parts and supplies for pumps, pipes, etc. , but quantities were not identified. This alternative would likely eliminate the air stripper media required for the supply well strippers. However, some additional materials may be associated with enhanced operation of the aerator at the IWTP.

Unrefined Materials Use

- None identified

Tons of Non-Hazardous Waste

- Not quantified. The RSE identified that plastic rings from the Building 163 stripper go to a landfill, as does iron oxide sludge from bottom of that stripper. These wastes are mixed with other wastes from the Installation prior to disposal. These wastes were not quantified in the RSE. This alternative would likely eliminate the iron oxide sludge requiring disposal from the supply well strippers. However, some additional waste may be associated with enhanced operation of the aerator at the IWTP.

Tons of Hazardous Waste

- None identified

Risks to On-Site Workers and from Transportation

- None identified

Heavy Truck Trips through Residential Areas

- None identified

GSR Team Calculations to Split Energy Results from SiteWise into "Direct" and "Indirect"
Alternative 2 - Eliminate Individual Water Supply Well Strippers

phase	Reported by SiteWise		Assigned by GSR Team from SiteWise Output			Added by GSR Team	Total Calculated by GSR Team
			Scope 1 (direct)	Scope 2 (indirect)	Scope 3 (indirect)	Scope 3 (indirect)	
	activity	energy used (MMBTU)	energy used (MMBTU)	energy used (MMBTU)	energy used (MMBTU)	energy used (MMBTU)	
P&T System Operation (remedial action operations tab)	Consumables	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Equipment	0.00	0.00	0.00	0.00	0.00	0.00
	Equipment Use and Misc	12772.90	5093.86	7240.62	438.42	0.00	12772.90
	Residual Handling	10855.56	8434.77	0.00	2420.79	0.00	10855.56
	Sub-Total	23628.46	13528.63	7240.62	2859.21	0.00	23628.46
total		23628.46	13528.63	7240.62	2859.21	0.00	23628.46

Note: *Electricity use reported by SiteWise Version 2.0 in units of kWh is "Direct Scope 1", meaning it is energy consumed at the location of the project. However, energy use associated with electricity reported by SiteWise in units of MMBtu is a life-cycle value which also includes a factor to account for energy used elsewhere required to generate the electricity ("Indirect Scope 2"). Here, 33% of the life-cycle value reported by SiteWise is considered to be "Scope 1" on-site energy use, and 67% is considered to be "Scope 2" energy used in electricity generation.*

SiteWise Version 2.0 uses a natural gas energy value from U.S. Department of Energy, Argonne National Laboratory, Transportation Technology R&D Center, GREET 1.8d.1, Fuel-Cycle model, 2010. This version of the GREET model reports that for Compressed Natural Gas (NA), approximately 22.3% of GHG emissions are upstream emissions (scope 3) and 77.7% are tailpipe emissions (scope 1). For this analysis, it is assumed that energy is used in these same proportions, and therefore the energy use reported by SiteWise is split between scope 3 and scope 1 in these ratios.

GSR Team Calculations to Split GHG Results from SiteWise into "Direct" and "Indirect"
Alternative 2 - Eliminate Individual Water Supply Well Strippers

phase	Reported by SiteWise		Assigned by GSR Team from SiteWise Output			Added by GSR Team	Total Calculated by GSR Team
			Scope 1 (direct)	Scope 2 (indirect)	Scope 3 (indirect)	Scope 3 (indirect)	
	activity	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	
P&T System Operation (remedial action operations tab)	Consumables	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Equipment	0.00	0.00	0.00	0.00	0.00	0.00
	Equipment Use and Misc	1143.54	125.81	981.63	36.11	0.00	1143.54
	Residual Handling	894.03	694.66	0.00	199.37	0.00	894.03
	Sub-Total	2037.58	820.47	981.63	235.48	0.00	2037.58
Total		2037.58	820.47	981.63	235.48	0.00	2037.58

Note: CO2e reported by SiteWise Version 2.0 for electricity use is all associated with generation of the electricity ("Indirect Scope 2").
SiteWise Version 2.0 uses natural gas emission factors from U.S. Department of Energy, Argonne National Laboratory, Transportation Technology R&D Center, GREET 1.8d.1, Fuel-Cycle model, 2010. This version of the GREET model reports that for Compressed Natural Gas (NA), approximately 22.3% of GHG emissions are upstream emissions (Scope 3) and 77.7% are tailpipe emissions (Scope 1). For this analysis, the GHG emissions reported by SiteWise are split between Scope 3 and Scope 1 in these ratios.

Appendix C-3

Alternative 3 - Direct Discharge to POTW from 17S, 17FF, and 17R

Appendix C3
Assumptions for SiteWise Input and Other Calculations
Lake City Army Ammunition Plant Pilot GSR Evaluation:

Alternative 3 - Direct Discharge to POTW from 17S, 17FF, and 17R

SiteWise "RA_ Alternative3_NoFR_1" Directory

All calculations were performed on an annual basis (i.e., "per year").

In this alternative, extracted water from 17S, 17FF, and 17R is discharged directly to the POTW without treatment at building 163. This eliminates all energy use associated with operation of building 163. Components of this alternative include:

- Combined stripper for 17AA and 17CC - ~15 HP blower and 15 HP transfer pump
- Stripper for 17BB - 10 HP blower and 15 HP transfer pump
- Stripper for 17EE - 10 HP blower and 15 HP transfer pump
- Stripper for 17JJ - 10 HP blower and 15 HP transfer pump
- Combined stripper for 17K and 17KK - 10 HP blower and 15 HP transfer pump

Note: range of HP on supply well pumps was designated 15-20 HP, so average of 17.5 HP was used for all supply well pumps

OU	Well Name	Location/Description	Pump (HP)	Typical Extraction Rate (gpm)	Air Stripper
1	17AA	Area 12, supply well also used for plume containment	15-20	~ 250	Shared
-	17CC	Supply well	15-20	~ 250	
-	17BB	Supply well	15-20	200	Stand-alone
-	17EE	Supply well	15-20	200	Stand-alone
-	17JJ	Supply well	15-20	200	Stand-alone
-	17K	Supply well	15-20	200	Shared
-	17KK	Supply well	15-20	200	
2	17R	Area 18 – between and just north of the two source areas	~15	~ 105	Bldg 163
2	17FF	Area 18 - north of toe of plume	~10	~ 70	Bldg 163
3	17S	Area 17D – at northern facility boundary	~15	~100	Bldg 163

- At supply wells 17K and 17KK, extraction occurs at only one of the two wells at a given time.

Alternative 3 – Overview

- Extracted water is transferred (two 25HP pumps, only one used at a time) to the Little Blue Valley Sewer District POTW.

The notes pertaining to SiteWise input are organized by the following tabs of the SiteWise input sheet:

- P&T System Operation – Uses “Remedial Action Operations” tab of the SiteWise input sheet

For each section of SiteWise, all the sections are listed, with pertinent information added only for those sections of the input sheet where data were added.

Other calculations done outside of SiteWise are then presented. These include the following:

- % of total energy from renewable resources
- Hazardous air pollutants
- Refined material use
- Unrefined material use
- Tons of non-hazardous waste
- Tons of hazardous waste
- Risks to on-site works and from transportation
- Heavy truck trips through residential areas

Additional tables are attached which show how SiteWise outputs were split into “direct” and “indirect” energy use and greenhouse gas emissions. For definitions of direct and indirect energy use and emissions, please refer to section 2.2.2 of the evaluation report.

No significant up-front costs would be expected, and total savings of approximately $131,500 per year could result from this change, as follows:

- Approximately $76,000 per year for elimination of the CATOX and associated blower (see Alternative 1)

- The savings for the 40 HP of electricity would lead to annual savings of approximately $18,000 assuming 0.85 load and 0.85 efficiency, a conversion factor of 0.746 kW/HP, and an estimated electricity rate of $0.07/kWh.

  40 HP * 0.8/0.75 * 0.746 * 24hrs/day * 365 days/yr * 0.95 * $0.07/kWh = ~$18,000/yr

- Air stripper media and disposal cost of approximately $17,500 would be eliminated.

- Assuming labor is reduced by 300 hrs at an approximate rate of $60/hr would save an additional $18,000 per year.

- At least $2,000 of savings in materials/supplies might be expected.

Input to the SiteWise tool and other supporting calculations are described in Appendix C3.

Alternative 3 – Operations

Scope of Work

- 6 pumps, 17.5 HP each (extraction from supply wells 17 AA, CC, EE, BB, JJ, KK/K). Note that extraction (electricity and water use) at these wells is not included in the footprint analysis because they provide water supply after treatment (i.e., not part of the remedy footprint).
- 1 pump, 10 HP (extraction well 17FF)
- 1 pump, 25 HP (transport of treated water to POTW (2, operated 1 at a time))
- 7 pumps, 15 HP each (transfer pumps on 5 individual air strippers (AA/CC, EE, BB, JJ, KK/K), extraction on 2 wells (17S and 17R))
- 4 blowers, 10 HP each (blowers on individual air strippers on supply wells 17 EE, BB, JJ, KK/K)
- 1 blowers, 15 HP (air stripper from supply wells 17 AA/CC)

Water usage (water extracted from the aquifer removed for other use as a resource) – using 2011rates at wells treated at Building 163 (other wells are used for water supply after treatment and therefore are not counted here), assigned as 105 gpm + 70 gpm + 100 gpm = 275 gpm * 1440 min/day * 365 day/yr = 144540000 gallons in a year.

Alternative 3 – Operations

<u>Input into "Remedial Action Operations" tab of SiteWise Input Sheet.xls</u>

- Baseline Information
    - Remedial Action Operations Cost and Duration
        - Total remedial action operations cost ($) – leave blank
        - Duration of remedial action operations (unit time) – 1 yr for this GSR evaluation

- Material Production
    - Well Materials
    - Treatment Chemicals & Materials
    - Treatment Media
    - Construction Materials
    - Well Decommissioning
    - Bulk Material Quantities

- Transportation
    - Personnel Transportation – Road
    - Personnel Transportation – Air
    - Personnel Transportation – Rail
    - Equipment Transportation – Road
    - Equipment Transportation – Air
    - Equipment Transportation – Rail
    - Equipment Transportation – Water

- Equipment Use
    - Earthwork
    - Drilling
    - Trenching
    - Pump Operation
        - Pump 1 – Extraction from well 17FF. Select Method 3. Grid region "SPNO" should be pre-selected; if not, go to Site Info tab and select. 1 pump at 10 HP operating continuously (24 hours per day * 365 days per year).
        - Pump 2 – 2 (only 1 operated at a time) to transport treated water from Bldg 163 to POTW. Select Method 3. 1 pump at 25 HP operating continuously (24 hours per day * 365 days per year).
        - Pump 3 – Transfer pumps on 5 individual air strippers and 2 extraction pumps on 17S and 17R. Select Method 3. 7 pumps at 15 HP operating continuously (24 hours per day * 365 days per year).

    - Diesel and Gasoline Pumps
    - Blower, Compressor, Mixer, and Other Equipment
        - Equipment 1 – Blowers on individual air strippers on supply wells 17 EE, BB, JJ, and KK/K. Select Method 1. 4 blowers at 10 HP operating continuously (24 hours per day * 365 days per year).
        - Equipment 2 – 1 blower on combined air stripper for supply wells 17 AA/CC. Select Method 1. 1 blower at 15 HP operating continuously (24 hours per day * 365 days per year).

Alternative 3 – Operations

- Generators
- Agricultural Equipment
- Capping Equipment
- Mixing Equipment
- Internal Combustion Engines
- Other Fueled Equipment
- Operator Labor
- Laboratory Analysis
- Other Known Onsite Activities

- Residual Handling
  - Residue Disposal/Recycling
  - Landfill Operations
  - Thermal/Catalytic Oxidizers

- Resource Consumption
  - Water Consumption
  - Onsite Land and Water Resource Consumption
    - Volume of groundwater or surface water lost (gal) – (water extracted from the aquifer removed for other use as a resource) – using 2011rates at wells treated at Building 163 (other wells are used for water supply after treatment and therefore are not counted here), assigned as 105 gpm + 70 gpm + 100 gpm = 275 gpm * 1440 min/day * 365 day/yr = 144540000 gallons in a year.

Once SiteWise input is complete, go to “SiteWise_Input Sheet ” for overall project and enter information (including Alternative File Name “Alternative3”). Then go to “Generate Alternative” tab and click button labeled “Click to generate alternative using previously entered alternative name”. Copies of the input and output summary sheets for this alternative are now located in the directory titled “RA_Alternative3 _NoFR_1”. To store the “Remedial Action Opeartions.xls” calculation sheet showing detailed calculations, open it in the overall SiteWise project directory when the appropriate input sheet is open, then do a “save as” to put it in the directory for this alternative using a name that indicates “will not update”. Then open that file and do “data->edit links” and break the links. If the input sheet for this alternative ever changes, then this calculation sheet needs to be re-saved.

To edit input parameters for this alternative, you must go back to the ORIGINAL SiteWise input sheet and import this alternative using the “Do you want to reload a previously saved remedial alternative in the SiteWise input sheet?” field on the “Site Info” tab. After making necessary changes to the input sheet, re-export the alternative by going to the “Generate Alternative” tab and clicking the button labeled “Click to replace an existing alternative with the same name”. Update saved calculation sheets as described above.

Other Supporting Calculations: Alternative 3 - Direct Discharge to POTW from 17S, 17FF, and 17R

% of Total Energy Usage from Renewable Resources

- Negligible. No on-site renewable energy generation was noted, and eGRID says that for this region of the country only 0.76% of the electricity is from renewable sources. Since not all of the energy use on this site is from electricity, the percentage would be even smaller.

Hazardous Air Pollutants

- None identified

.

Refined Materials Use

- Not quantified. The RSE identified use of air stripper media, CATOX calibration gases, and maintenance parts and supplies for pumps, pipes, etc. , but quantities were not identified. This alternative would eliminate the use of air stripper media and CATOX calibration gases for Building 163.

Unrefined Materials Use

- None identified

Tons of Non-Hazardous Waste

- Not quantified. The RSE identified that plastic rings from the Building 163 stripper go to a landfill, as does iron oxide sludge from bottom of that stripper. These wastes are mixed with other wastes from the Installation prior to disposal. These wastes were not quantified in the RSE. This alternative would eliminate the iron oxide sludge from the air stripper media for Building 163.

Tons of Hazardous Waste

- None identified

Risks to On-Site Workers and from Transportation

- None identified

Heavy Truck Trips through Residential Areas

- None identified

GSR Team Calculations to Split Energy Results from SiteWise into "Direct" and "Indirect"
Alternative 3 - Direct Discharge to POTW from 17S, 17FF, and 17R

phase	Reported by SiteWise		Assigned by GSR Team from SiteWise Output			Added by GSR Team	Total Calculated by GSR Team
			Scope 1 (direct)	Scope 2 (indirect)	Scope 3 (indirect)	Scope 3 (indirect)	
	activity	energy used (MMBTU)	energy used (MMBTU)	energy used (MMBTU)	energy used (MMBTU)	energy used (MMBTU)	
P&T System Operation (remedial action operations tab)	Consumables	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Equipment	0.00	0.00	0.00	0.00	0.00	0.00
	Equipment Use and Misc	13170.91	4346.40	8824.51	0.00	0.00	13170.91
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-Total	13170.91	4346.40	8824.51	0.00	0.00	13170.91
total		13170.91	4346.40	8824.51	0.00	0.00	13170.91

Note: Electricity use reported by SiteWise Version 2.0 in units of kWh is "Direct Scope 1", meaning it is energy consumed at the location of the project. However, energy use associated with electricity reported by SiteWise in units of MMBtu is a life-cycle value which also includes a factor to account for energy used elsewhere required to generate the electricity ("Indirect Scope 2"). Here, 33% of the life-cycle value reported by SiteWise is considered to be "Scope 1" on-site energy use, and 67% is considered to be "Scope 2" energy used in electricity generation.

SiteWise Version 2.0 uses a natural gas energy value from U.S. Department of Energy, Argonne National Laboratory, Transportation Technology R&D Center, GREET 1.8d.1, Fuel-Cycle model, 2010. This version of the GREET model reports that for Compressed Natural Gas (NA), approximately 22.3% of GHG emissions are upstream emissions (scope 3) and 77.7% are tailpipe emissions (scope 1). For this analysis, it is assumed that energy is used in these same proportions, and therefore the energy use reported by SiteWise is split between scope 3 and scope 1 in these ratios.

GSR Team Calculations to Split GHG Results from SiteWise into "Direct" and "Indirect"
Alternative 3 - Direct Discharge to POTW from 17S, 17FF, and 17R

phase	Reported by SiteWise		Assigned by GSR Team from SiteWise Output			Added by GSR Team	Total Calculated by GSR Team
			Scope 1 (direct)	Scope 2 (indirect)	Scope 3 (indirect)	Scope 3 (indirect)	
	activity	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	
P&T System Operation (remedial action operations tab)	Consumables	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Equipment	0.00	0.00	0.00	0.00	0.00	0.00
	Equipment Use and Misc	1196.36	0.00	1196.36	0.00	0.00	1196.36
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-Total	1196.36	0.00	1196.36	0.00	0.00	1196.36
Total		1196.36	0.00	1196.36	0.00	0.00	1196.36

Note: CO2e reported by SiteWise Version 2.0 for electricity use is all associated with generation of the electricity ("Indirect Scope 2").
SiteWise Version 2.0 uses natural gas emission factors from U.S. Department of Energy, Argonne National Laboratory, Transportation Technology R&D Center, GREET 1.8d.1, Fuel-Cycle model, 2010. This version of the GREET model reports that for Compressed Natural Gas (NA), approximately 22.3% of GHG emissions are upstream emissions (Scope 3) and 77.7% are tailpipe emissions (Scope 1). For this analysis, the GHG emissions reported by SiteWise are split between Scope 3 and Scope 1 in these ratios.

Appendix C-4

Alternative 4 - Treatment of All Water at On-Site Treatment Plant for use as Water Supply, with no Pre-Treatment at Building 163

Appendix C4
Assumptions for SiteWise Input and Other Calculations
Lake City Army Ammunition Plant Pilot GSR Evaluation:

Alternative 4 - Treatment of All Water at On-Site Treatment Plant for use as Water Supply, with no Pre-Treatment at Building 163

SiteWise "RA_ Alternative4_NoFR_1" Directory

All calculations were performed on an annual basis (i.e., "per year").

This alternative involves sending the combined flow from the supply wells and extraction wells 17FF, 17S, and 17R to the on-site treatment plant and cutting out air strippers currently used on individual supply wells. This alternative would also eliminate energy use associated with operation of building 163. In addition, this alternative involves the following assumptions:

- A 30 HP blower added to the current plant for additional treatment capacity
- Same combined flow rate to the IWTP as is currently produced by the supply wells (i.e., current supply well extraction will be reduced by the amount of added flowrate (~275 gpm) from wells 17R, 17FF, and 17S)
- A detailed estimate for piping from Building 163 area to bring water to the IWTP has not been performed, a rough cost is estimated (5,000 ft * $55/ft = $275,000 + $75,000 design/misc = $350,000)

In this alternative, extraction pumps at supply wells and remedy wells would pump directly to the central treatment plant. This system would include the following pumps used for extraction:

OU	Well Name	Location/Description	Pump (HP)	Revised Extraction Rate (gpm)
1	17AA	Area 12, supply well also used for plume containment	15-20	~ 1225 (current combined rate of ~1500 minus ~275 from wells below)
-	17CC	Supply well	15-20	
-	17BB	Supply well	15-20	
-	17EE	Supply well	15-20	
-	17JJ	Supply well	15-20	
-	17K	Supply well	15-20	
-	17KK	Supply well	15-20	
2	17R	Area 18 – between and just north of the two source areas	~15	~ 105

Alternative 4 – Overview

2	17FF	Area 18 - north of toe of plume	~10	~ 70
3	17S	Area 17D – at northern facility boundary	~15	~100

- At supply wells 17K and 17KK, extraction occurs at only one of the two wells at a given time.

- A 25HP pump (there are two pumps, but only one operates at a time) would still be needed to move the water from the EQ tank.

The notes pertaining to SiteWise input are organized by the following tabs of the SiteWise input sheet:

- P&T System Operation – Uses "Remedial Action Operations" tab of the SiteWise input sheet

For each section of SiteWise, all the sections are listed, with pertinent information added only for those sections of the input sheet where data were added.

Other calculations done outside of SiteWise are then presented. These include the following:

- % of total energy from renewable resources
- Hazardous air pollutants
- Refined material use
- Unrefined material use
- Tons of non-hazardous waste
- Tons of hazardous waste
- Risks to on-site works and from transportation
- Heavy truck trips through residential areas

Additional tables are attached which show how SiteWise outputs were split into "direct" and "indirect" energy use and greenhouse gas emissions. For definitions of direct and indirect energy use and emissions, please refer to section 2.2.2 of the evaluation report.

The potential savings annual savings could be on the order of $600,000 per year for the Building 163 system, plus savings of approximately $46,000 per year for eliminating the supply well strippers and transfer pumps (see Alternative 2). There may be added savings from eliminating one or more current supply well extraction pumps (not quantified). The payback period would depend on the magnitude of the total up-front costs versus the annual cost savings. There would be up-front costs for upgrading the IWTP (estimated at $200,000 in Alternative 2) and an up-front cost for piping from Building 163 to the IWTP which could be substantial. A detailed estimate for piping from Building 163 area to bring water to the IWTP has not been performed, a rough cost is estimated (5,000 ft * $55/ft = $275,000 + $75,000 design/misc = $350,000). Using a very preliminary estimate for up-front costs of approximately $550,000 for IWTP improvements plus piping, the payback period might be less than 1 year. Even if the piping cost was much higher, payback would very likely occur within 2-3 years.

Alternative 4 - Operation

<u>*Scope of Work*</u>

- 6 pumps, 17.5 HP each (extraction from supply wells 17 AA, CC, EE, BB, JJ, KK/K). Note that extraction (electricity and water use) at these wells is not included in the footprint analysis because they provide water supply after treatment (i.e., not part of the remedy footprint).
- 1 pump, 10 HP (extraction well 17FF). Note that extraction at this well is not included in the footprint analysis because in this alternative it provides water supply after treatment (i.e., no longer a part of the remedy footprint).
- 1 pump, 25 HP (transport treated water from equalization tank (2, operated 1 at a time))
- 2 pumps, 15 HP each (extraction on 2 wells (17S and 17R)). Note that extraction at these wells is not included in the footprint analysis because in this alternative they provide water supply after treatment (i.e., no longer a part of the remedy footprint).
- 1 blower, 30 HP (blower added to on-site treatment plant for additional treatment of supply well water no longer being pretreated)

Water usage (water extracted from the aquifer) – No reduction in water resources since all extracted water will be used for water supply.

Alternative 4 - Operation

<u>Input into “Remedial Action Operations” tab of SiteWise Input Sheet.xls</u>

- Baseline Information
    - Remedial Action Operations Cost and Duration
        - Total remedial action operations cost ($) – leave blank
        - Duration of remedial action operations (unit time) – 1 yr for this GSR evaluation

- Material Production
    - Well Materials
    - Treatment Chemicals & Materials
    - Treatment Media
    - Construction Materials
    - Well Decommissioning
    - Bulk Material Quantities

- Transportation
    - Personnel Transportation – Road
    - Personnel Transportation – Air
    - Personnel Transportation – Rail
    - Equipment Transportation – Road
    - Equipment Transportation – Air
    - Equipment Transportation – Rail
    - Equipment Transportation – Water

- Equipment Use
    - Earthwork
    - Drilling
    - Trenching
    - Pump Operation
        - Pump 1 – 2 (only 1 operated at a time) to transport treated water from equalization tank. Select Method 3. Grid region “SPNO” should be pre-selected; if not, go to Site Info tab and select. 1 pump at 25 HP operating continuously (24 hours per day * 365 days per year).

    - Diesel and Gasoline Pumps
    - Blower, Compressor, Mixer, and Other Equipment
        - Equipment 1 – 1 blower added to on-site treatment plant for additional treatment. Select Method 1. 1 blower at 30 HP operating continuously (24 hours per day * 365 days per year).

    - Generators
    - Agricultural Equipment
    - Capping Equipment
    - Mixing Equipment
    - Internal Combustion Engines
    - Other Fueled Equipment
    - Operator Labor
    - Laboratory Analysis

Alternative 4 - Operation

- Other Known Onsite Activities

- Residual Handling
  - Residue Disposal/Recycling
  - Landfill Operations
  - Thermal/Catalytic Oxidizers

- Resource Consumption
  - Water Consumption
  - Onsite Land and Water Resource Consumption
    - Volume of groundwater or surface water lost (gal) – None since all extracted water will be used for water supply.

Once SiteWise input is complete, go to "SiteWise_Input Sheet " for overall project and enter information (including Alternative File Name "Alternative4"). Then go to "Generate Alternative" tab and click button labeled "Click to generate alternative using previously entered alternative name". Copies of the input and output summary sheets for this alternative are now located in the directory titled "RA_Alternative4 _NoFR_1". To store the "Remedial Action Opeartions.xls" calculation sheet showing detailed calculations, open it in the overall SiteWise project directory when the appropriate input sheet is open, then do a "save as" to put it in the directory for this alternative using a name that indicates "will not update". Then open that file and do "data->edit links" and break the links. If the input sheet for this alternative ever changes, then this calculation sheet needs to be re-saved.

To edit input parameters for this alternative, you must go back to the ORIGINAL SiteWise input sheet and import this alternative using the "Do you want to reload a previously saved remedial alternative in the SiteWise input sheet?" field on the "Site Info" tab. After making necessary changes to the input sheet, re-export the alternative by going to the "Generate Alternative" tab and clicking the button labeled "Click to replace an existing alternative with the same name". Update saved calculation sheets as described above.

Other Supporting Calculations: Alternative 4 - Treatment of All Water at On-Site Treatment Plant for use as Water Supply, with no Pre-Treatment at Building 163

% of Total Energy Usage from Renewable Resources

- Negligible. No on-site renewable energy generation was noted, and eGRID says that for this region of the country only 0.76% of the electricity is from renewable sources. Since not all of the energy use on this site is from electricity, the percentage would be even smaller.

Hazardous Air Pollutants

- None identified

.

Refined Materials Use

- Not quantified. The RSE identified use of air stripper media, CATOX calibration gases, and maintenance parts and supplies for pumps, pipes, etc. , but quantities were not identified. This alternative would eliminate the use of air stripper media and CATOX calibration gases for Building 163, and air stripper media for the supply well strippers. However, some additional materials may be associated with enhanced operation of the aerator at the IWTP.

Unrefined Materials Use

- None identified

Tons of Non-Hazardous Waste

- Not quantified. The RSE identified that plastic rings from the Building 163 stripper go to a landfill, as does iron oxide sludge from bottom of that stripper. These wastes are mixed with other wastes from the Installation prior to disposal. These wastes were not quantified in the RSE. This alternative would eliminate the iron oxide sludge from the air stripper media for Building 163 and for the supply well strippers. However, some additional waste may be associated with enhanced operation of the aerator at the IWTP.

Tons of Hazardous Waste

- None identified

Risks to On-Site Workers and from Transportation

- None identified

Heavy Truck Trips through Residential Areas

- None identified

GSR Team Calculations to Split Energy Results from SiteWise into "Direct" and "Indirect"
Alternative 4 - Treatment of All Water at On-Site Treatment Plant for use as Water Supply, with no Pre-Treatment at Building 163

	Reported by SiteWise		Assigned by GSR Team from SiteWise Output			Added by GSR Team	
			Scope 1 (direct)	Scope 2 (indirect)	Scope 3 (indirect)	Scope 3 (indirect)	
phase	activity	energy used (MMBTU)	energy used (MMBTU)	energy used (MMBTU)	energy used (MMBTU)	energy used (MMBTU)	Total Calculated by GSR Team
P&T System Operation (remedial action operations tab)	Consumables	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Equipment	0.00	0.00	0.00	0.00	0.00	0.00
	Equipment Use and Misc	3714.87	1225.91	2488.96	0.00	0.00	3714.87
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-Total	3714.87	1225.91	2488.96	0.00	0.00	3714.87
total		3714.87	1225.91	2488.96	0.00	0.00	3714.87

Note: Electricity use reported by SiteWise Version 2.0 in units of kWh is "Direct Scope 1", meaning it is energy consumed at the location of the project. However, energy use associated with electricity reported by SiteWise in units of MMBtu is a life-cycle value which also includes a factor to account for energy used elsewhere required to generate the electricity ("Indirect Scope 2"). Here, 33% of the life-cycle value reported by SiteWise is considered to be "Scope 1" on-site energy use, and 67% is considered to be "Scope 2" energy used in electricity generation.

SiteWise Version 2.0 uses a natural gas energy value from U.S. Department of Energy, Argonne National Laboratory, Transportation Technology R&D Center, GREET 1.8d.1, Fuel-Cycle model, 2010. This version of the GREET model reports that for Compressed Natural Gas (NA), approximately 22.3% of GHG emissions are upstream emissions (scope 3) and 77.7% are tailpipe emissions (scope 1). For this analysis, it is assumed that energy is used in these same proportions, and therefore the energy use reported by SiteWise is split between scope 3 and scope 1 in these ratios.

GSR Team Calculations to Split GHG Results from SiteWise into "Direct" and "Indirect"
Alternative 4 - Treatment of All Water at On-Site Treatment Plant for use as Water Supply, with no Pre-Treatment at Building 163

phase	Reported by SiteWise		Assigned by GSR Team from SiteWise Output			Added by GSR Team	Total Calculated by GSR Team
			Scope 1 (direct)	Scope 2 (indirect)	Scope 3 (indirect)	Scope 3 (indirect)	
	activity	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	
P&T System Operation (remedial action operations tab)	Consumables	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Equipment	0.00	0.00	0.00	0.00	0.00	0.00
	Equipment Use and Misc	337.44	0.00	337.44	0.00	0.00	337.44
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-Total	337.44	0.00	337.44	0.00	0.00	337.44
Total		337.44	0.00	337.44	0.00	0.00	337.44

Note: CO2e reported by SiteWise Version 2.0 for electricity use is all associated with generation of the electricity ("Indirect Scope 2").
SiteWise Version 2.0 uses natural gas emission factors from U.S. Department of Energy, Argonne National Laboratory, Transportation Technology R&D Center, GREET 1.8d.1, Fuel-Cycle model, 2010. This version of the GREET model reports that for Compressed Natural Gas (NA), approximately 22.3% of GHG emissions are upstream emissions (Scope 3) and 77.7% are tailpipe emissions (Scope 1). For this analysis, the GHG emissions reported by SiteWise are split between Scope 3 and Scope 1 in these ratios.

Appendix D

Assumptions for SiteWise Input and Other Calculations for Molasses, Molwhey, and Vegetable Oil Footprint Comparison Case Studies

Appendix D-1

Substrate Comparison Case Study - Molasses

Appendix D-1
Assumptions for SiteWise Input and Other Calculations
Substrate Comparison Case Study: Molasses

SiteWise "RA_Molasses_NoFR_1" Directory

For the purposes of costing and footprinting, this alternative is assumed to involve the following components:

- Molasses injections for ERD

Unless otherwise noted, SiteWise inputs are based on reasonable assumptions for substrate injections.

For this case study, all SiteWise inputs are entered into the "Remedial Action Operations" tab of SiteWise input sheet.

For each section of SiteWise, all the sections are listed, with pertinent information added only for those sections of the input sheet where data were added.

Other calculations done outside of SiteWise are then presented. These include the following:

- % of total energy from renewable resources
- Hazardous air pollutants
- Refined material use
- Unrefined material use
- Tons of non-hazardous waste
- Tons of hazardous waste
- % of Potential Waste Recycled
- Risks to on-site works and from transportation
- Heavy truck trips through residential areas

Additional tables are attached which show how SiteWise outputs were split into "direct" and "indirect" energy use and greenhouse gas emissions. For definitions of direct and indirect energy use and emissions, please refer to section 2.2.2 of the evaluation report.

No cost calculations were attempted for this case study.

Molasses – Detailed Description and SiteWise Inputs

Scope of Work

The following components are assumed for footprinting:

- Materials: Molasses
  - Half-life of 20 days
  - 500 lbs of molasses used for each of 5 injection wells per event
  - 5-week injection event 4 times per year
  - 500 lbs per injection well * 5 wells * 4 events per year = 10,000 lbs molasses per year
  - Use the following footprint conversion factors for this material:
    - Energy Use: 0.0044 MMBtu/lb
    - CO2e: 0.48 lbs CO2e/lb
    - NOx: 0.0011 lbs NOx/lb
    - SOx: 0.00024 lbs SOx/lb
    - PM: 0.0000041 lbs PM/lb

    (Offset values for molasses obtained from the module for sugar from Nielsen PH, Nielsen AM, Weidema BP, Dalgaard R and Halberg N (2003). LCA food data base. www.lcafood.dk, Sugar Production based on Danisco Sugar Author: Per H. Nielsen July 2003)

- Water Use
  - Assume that for 500 lbs of molasses used per injection point per event, ~3000 gallons of water will be needed to make a 2% solution (since 500 lbs molasses / (8.33 lbs per gallon water * 3,000 gallons water) = 0.02)
  - 3,000 gallons per injection well * 5 wells * 4 events per year = 60,000 gal water per year

- Pump Operation
  - Assume that a 5 HP transfer pump operating at 50 gpm will be required to move water needed for substrate solution. Not that this pump may be bigger or smaller than what would be needed for these injections, but since it will only be operating for a fraction of the time (i.e. not continuously year-round) that it constitutes a relatively minor footprint, and is included here mainly as an example of a remedy component that should be included in this sort of analysis.
  - 60,000 gals water used per year / 50 gpm = 1200 hours of pump operation per year total.

- Personnel Transport
  - 1 person coming from 25 miles away each day during the 5-week injection periods (5 weeks * 5 days a week * 4 events per year = 100 round trips to the site per year)

- Materials Transport
  - Molasses shipped from 200 miles away
  - 2 shipments of 5,000 lbs each per year

Molasses – Detailed Description and SiteWise Inputs

Input into "Remedial Action Operations" tab of SiteWise Input Sheet.xls

- Baseline Information
  - Remedial Action Operations Cost and Duration
    - Total remedial action operations cost ($) – leave blank in SiteWise
    - Duration of remedial action operations (unit time) – 1 yr for this GSR evaluation because inputs are calculated on a yearly basis

- Material Production
  - Well Materials
  - Treatment Chemicals & Materials
  - Treatment Media
  - Construction Materials
  - Well Decommissioning
  - Bulk Material Quantities
    - Since SiteWise does not have values for molasses in look up table 1c, the following conversion factors (derived from the values listed in the Scope of Work above) were added:

Material	kg CO2 e / kg	MJ /kg	MWH /kg
Material A - Molasses	**4.80E-01**	**1.02E+01**	**2.84E-03**

    - Material 1 – Yearly molasses usage. Select Material A – Molasses, units in pounds, 500 lbs per well * 5 wells * 4 events per yr = 10,000 lbs total

- Transportation
  - Personnel Transportation – Road
    - Trip 1 – Field technician overseeing injections. Select light truck, gasoline. 50 miles round trip, 5 week injection events * 5 days a week * 4 events per year = 100 round trips to the site per year, 1 traveler.
  - Personnel Transportation – Air
  - Personnel Transportation – Rail
  - Equipment Transportation – Road
    - Trip 1 – Molasses shipments to site. Select diesel fuel. 200 miles one way * 2 shipments per year = 400 miles traveled; 5,000 lb load / 2,000 lbs per ton = 2.5 tons (per shipment).
    - Trip 2 – Empty return trips from molasses delivery. Select diesel fuel. 200 miles one way * 2 empty return trips per year = 400 miles traveled; enter 0 tons for empty truck trips.
  - Equipment Transportation – Air
  - Equipment Transportation – Rail
  - Equipment Transportation – Water

- Equipment Use
  - Earthwork
  - Drilling
  - Trenching
  - Pump Operation (Electricity Region of "SPNO" is specified on "Site Info" tab of SiteWise)

        - Pump 1 – Transfer pump for moving substrate solution. Be sure to select "Method 3" from the drop-down menu at the top of the "Pump Operation" section. Then, under the "Method 3 - NAME PLATE SPECIFICATIONS ARE KNOWN" subsection, enter 5 for the HP, 1 pump, operating for 1200 hours (60,000 gals water used per year / 50 gpm pumping rate).
    - Diesel and Gasoline Pumps
    - Blower, Compressor, Mixer, and Other Equipment
    - Generators
    - Agricultural Equipment
    - Capping Equipment
    - Mixing Equipment
    - Internal Combustion Engines
    - Other Fueled Equipment
    - Operator Labor
    - Laboratory Analysis
    - Other Known Onsite Activities
        - Water consumption (gallons) – 3,000 gal per well * 5 wells * 4 events per year = 60,000 gallons

- Residual Handling
    - Residue Disposal/Recycling
    - Landfill Operations
    - Thermal/Catalytic Oxidizers

- Resource Consumption
    - Water Consumption
    - Onsite Land and Water Resource Consumption

Once SiteWise input is complete, go to "SiteWise_Input Sheet" for overall project and enter information (including Alternative File Name "Molasses"). Then go to "Generate Alternative" tab and click button labeled "Click to generate alternative using previously entered alternative name". Copies of the input and output summary sheets for this alternative are now located in the directory titled "RA_Molasses_NoFR_1". To store the "Remedial Action Operations.xls" calculation sheet showing detailed calculations, open it in the overall SiteWise project directory when the appropriate input sheet is open, then do a "save as" to put it in the directory for this alternative using a name that indicates "will not update". Then open that file and do "data->edit links" and break the links. If the input sheet for this alternative ever changes, then this calculation sheet needs to be re-saved.

To edit input parameters for this alternative, you must go back to the ORIGINAL SiteWise input sheet and import this alternative using the "Do you want to reload a previously saved remedial alternative in the SiteWise input sheet?" field on the "Site Info" tab. After making necessary changes to the input sheet, re-export the alternative by going to the "Generate Alternative" tab and clicking the button labeled "Click to replace an existing alternative with the same name". Update saved calculation sheets as described above.

Appendix D-2

Substrate Comparison Case Study - Molwhey

Other Supporting Calculations:
Substrate Comparison Case Study: Molasses

% of Total Energy Usage from Renewable Resources

- According to eGRID (http://cfpub.epa.gov/egridweb/index.cfm), the percentage of electricity from renewable sources for region SPNO is 0.76%. Thus, it is assumed that 0.76% of the on-site electricity use is from renewable resources. The on-site electrical use is estimated at 46.26 MMBTU in SiteWise. The total energy use (on-site and off-site) is estimated at 139.93 MMBTU. Assuming all fuels used and all other energy use for production of materials are from non-renewable sources, then the % of total energy from renewable sources is 0.0076 * (46.26 / 139.93) = 0.25%.

Hazardous Air Pollutants

- None identified

.

Refined Materials Use

- 10,000 lbs molasses

Unrefined Materials Use

- None identified

Tons of Non-Hazardous Waste

- None identified

Tons of Hazardous Waste

- None identified

% of Potential Waste Recycled

- Since molasses is a by-product of sugar production, some or all of the molasses used as substrate could be considered “potential waste” (particularly if the molasses is not food-grade).

Risks to On-Site Workers and from Transportation

- Based on SiteWise output
    - On-Site worker injuries or fatalities = 0
    - Transportation related injuries or fatalities = 0.00369

Heavy Truck Trips through Residential Areas

- None identified

Appendix D-2
Assumptions for SiteWise Input and Other Calculations
Substrate Comparison Case Study: Molwhey

SiteWise "RA_Molwhey_NoFR_1" Directory

For the purposes of costing and footprinting, this alternative is assumed to involve the following components:

- Molwhey (50% molasses and 50% cheese whey) injections for ERD
- Assume that the same amount of substrate as with molasses will be used, but that injection events will occur less frequently because of the extended half-life (35 days)

Unless otherwise noted, SiteWise inputs are based on reasonable assumptions for substrate injections.

For this case study, all SiteWise inputs are entered into the "Remedial Action Operations" tab of SiteWise input sheet

For each section of SiteWise, all the sections are listed, with pertinent information added only for those sections of the input sheet where data were added.

Other calculations done outside of SiteWise are then presented. These include the following:

- % of total energy from renewable resources
- Hazardous air pollutants
- Refined material use
- Unrefined material use
- Tons of non-hazardous waste
- Tons of hazardous waste
- % of Potential Waste Recycled
- Risks to on-site works and from transportation
- Heavy truck trips through residential areas

Additional tables are attached which show how SiteWise outputs were split into "direct" and "indirect" energy use and greenhouse gas emissions. For definitions of direct and indirect energy use and emissions, please refer to section 2.2.2 of the evaluation report.

No cost calculations were attempted for this case study.

Molwhey – Detailed Description and SiteWise Inputs

Scope of Work

The following components are considered for footprinting:

- Materials: Molwhey (50% Molasses, 50% Cheese Whey)
    - Half-life of 35 days
    - 500 lbs of molwhey used for each of 5 injection wells per event
    - 5-week injection event 2.3 times per year
    - 500 lbs per injection well * 5 wells * 2.3 events per year = 5,750 lbs molwhey per year
    - Combine the following footprint conversion factors for this material:
        - Molasses
            - Energy Use: 0.0044 MMBtu/lb
            - CO2e: 0.48 lbs CO2e/lb
            - NOx: 0.0011 lbs NOx/lb
            - SOx: 0.00024 lbs SOx/lb
            - PM: 0.0000041 lbs PM/lb

        (Offset values for molasses obtained from the module for sugar from Nielsen PH, Nielsen AM, Weidema BP, Dalgaard R and Halberg N (2003). LCA food data base. www.lcafood.dk, Sugar Production based on Danisco Sugar Author: Per H. Nielsen July 2003)

        - Cheese Whey
            - Energy Use: 0.0025 MMBtu/lb
            - CO2e: 0.031 lbs CO2e/lb
            - NOx: 0.000062 lbs NOx/lb
            - SOx: 0.000033 lbs SOx/lb
            - PM: 0.000002 lbs PM/lb

        (Offset values for cheese whey obtained from the module for yellow cheese from Nielsen PH, Nielsen AM, Weidema BP, Dalgaard R and Halberg N (2003). LCA food data base. www.lcafood.dk, Andersen M and Jensen JD (2003). Marginale producenter af udvalgte basislevnedsmidler (in Danish) Udkast d. 5. februar 2003)

    - Averaging the values for the two materials above yields the following conversion factors for a 50% molasses, 50% cheese whey mixture:
        - Molwhey
            - Energy Use: 0.00345 MMBtu/lb
            - CO2e: 0.2555 lbs CO2e/lb
            - NOx: 0.000581 lbs NOx/lb
            - SOx: 0.0001365 lbs SOx/lb
            - PM: 0.00000305 lbs PM/lb

- Water Use
    - Assume that for 500 lbs of molwhey used per injection point per event, ~3000 gallons of water will be needed to make a 2% solution, since 500 lbs molwhey / (8.33 lbs per gallon water * 3,000 gallons water) = 0.02

  - 3,000 gallons per injection well * 5 wells * 2.3 events per year = 34,500 gal water per year

- Pump Operation
  - Assume that a 5 HP transfer pump operating at 50 gpm will be required to move water needed for substrate solution. Not that this pump may be bigger or smaller than what would be needed for these injections, but since it will only be operating for a fraction of the time (i.e. not continuously year-round) that it constitutes a relatively minor footprint, and is included here mainly as an example of a remedy component that should be included in this sort of analysis.
  - 34,500 gals water used per year / 50 gpm = 690 hours of pump operation per year total.

- Personnel Transport
  - 1 person coming from 25 miles away each day during the 5-week injection periods (5 weeks * 5 days a week * 2.3 events per year = 57.5 round trips to the site per year)

- Materials Transport
  - Molwhey shipped from 200 miles away
  - 2 shipments of 2,875 lbs each per year

Molwhey – Detailed Description and SiteWise Inputs

Input into "Remedial Action Operations" tab of SiteWise Input Sheet.xls

- Baseline Information
  - Remedial Action Operations Cost and Duration
    - Total remedial action operations cost ($) – leave blank in SiteWise
    - Duration of remedial action operations (unit time) – 1 yr for this GSR evaluation because inputs are calculated on a yearly basis

- Material Production
  - Well Materials
  - Treatment Chemicals & Materials
  - Treatment Media
  - Construction Materials
  - Well Decommissioning
  - Bulk Material Quantities
    - Since SiteWise does not have values for molwhey in look up table 1c, the following conversion factors (derived from the values listed in the Scope of Work above) were added:

Material	kg CO2 e / kg	MJ /kg	MWH /kg
Material B - Molwhey	**2.56E-01**	**8.02E+00**	**2.23E-03**

    - Material 1 – Yearly molwhey usage. Select Material B – Molwhey, units in pounds, 500 lbs per well * 5 wells * 2.3 events per year = 5,750 lbs total

- Transportation
  - Personnel Transportation – Road
    - Trip 1 – Field technician overseeing injections. Select light truck, gasoline. 50 miles round trip, 5 week injection events * 5 days a week * 2.3 events per year = 57.5 round trips to the site per year, 1 traveler.
  - Personnel Transportation – Air
  - Personnel Transportation – Rail
  - Equipment Transportation – Road
    - Trip 1 – Molwhey shipments to site. Select diesel fuel. 200 miles one way * 2 shipments per year = 400 miles traveled; 2,875 lb load / 2,000 lbs per ton = 1.4375 tons (per shipment).
    - Trip 2 – Empty return trips from molwhey delivery. Select diesel fuel. 200 miles one way * 2 empty return trips per year = 400 miles traveled; enter 0 tons for empty truck trips.
  - Equipment Transportation – Air
  - Equipment Transportation – Rail
  - Equipment Transportation – Water

- Equipment Use
  - Earthwork
  - Drilling
  - Trenching
  - Pump Operation (Electricity Region of "SPNO" is specified on "Site Info" tab of SiteWise)

        - Pump 1 – Transfer pump for moving substrate solution. Be sure to select "Method 3" from the drop-down menu at the top of the "Pump Operation" section. Then, under the "Method 3 - NAME PLATE SPECIFICATIONS ARE KNOWN" subsection, enter 5 for the HP, 1 pump, operating for 690 hours (34,500 gals water used per year / 50 gpm pumping rate).
    - Diesel and Gasoline Pumps
    - Blower, Compressor, Mixer, and Other Equipment
    - Generators
    - Agricultural Equipment
    - Capping Equipment
    - Mixing Equipment
    - Internal Combustion Engines
    - Other Fueled Equipment
    - Operator Labor
    - Laboratory Analysis
    - Other Known Onsite Activities
        - Water consumption (gallons) – 3,000 gal per well * 5 wells * 2.3 events per year = 34,500 gallons

- Residual Handling
    - Residue Disposal/Recycling
    - Landfill Operations
    - Thermal/Catalytic Oxidizers

- Resource Consumption
    - Water Consumption
    - Onsite Land and Water Resource Consumption

Once SiteWise input is complete, go to "SiteWise_Input Sheet" for overall project and enter information (including Alternative File Name "Molwhey"). Then go to "Generate Alternative" tab and click button labeled "Click to generate alternative using previously entered alternative name". Copies of the input and output summary sheets for this alternative are now located in the directory titled "RA_Molwhey_NoFR_1". To store the "Remedial Action Operations.xls" calculation sheet showing detailed calculations, open it in the overall SiteWise project directory when the appropriate input sheet is open, then do a "save as" to put it in the directory for this alternative using a name that indicates "will not update". Then open that file and do "data->edit links" and break the links. If the input sheet for this alternative ever changes, then this calculation sheet needs to be re-saved.

To edit input parameters for this alternative, you must go back to the ORIGINAL SiteWise input sheet and import this alternative using the "Do you want to reload a previously saved remedial alternative in the SiteWise input sheet?" field on the "Site Info" tab. After making necessary changes to the input sheet, re-export the alternative by going to the "Generate Alternative" tab and clicking the button labeled "Click to replace an existing alternative with the same name". Update saved calculation sheets as described above.

Other Supporting Calculations:
Substrate Comparison Case Study: Molwhey

% of Total Energy Usage from Renewable Resources

- According to eGRID (http://cfpub.epa.gov/egridweb/index.cfm), the percentage of electricity from renewable sources for region SPNO is 0.76%. Thus, it is assumed that 0.76% of the on-site electricity use is from renewable resources. The on-site electrical use is estimated at 26.60 MMBTU in SiteWise. The total energy use (on-site and off-site) is estimated at 81.28 MMBTU. Assuming all fuels used and all other energy use for production of materials are from non-renewable sources, then the % of total energy from renewable sources is 0.0076 * (26.60 / 81.28) = 0.25%.

Hazardous Air Pollutants

- None identified

.

Refined Materials Use

- 5,750 lbs molwhey

Unrefined Materials Use

- None identified

Tons of Non-Hazardous Waste

- None identified

Tons of Hazardous Waste

- None identified

% of Potential Waste Recycled

- Since molasses is a by-product of sugar production and whey is a by-product of cheese production, some or all of the molwhey used as substrate could be considered “potential waste” (particularly if the materials are not food-grade).

Risks to On-Site Workers and from Transportation

- Based on SiteWise output
  - On-Site worker injuries or fatalities = 0
  - Transportation related injuries or fatalities = 0.00234

Heavy Truck Trips through Residential Areas

- None identified

Appendix D-3

Substrate Comparison Case Study - Vegetable Oil (60 Day Half-Life)

Appendix D-3
Assumptions for SiteWise Input and Other Calculations
Substrate Comparison Case Study: Vegetable Oil (60 Day Half-Life)

SiteWise "RA_Veg Oil 60_NoFR_1" Directory

For the purposes of costing and footprinting, this alternative is assumed to involve the following components:

- Emulsified vegetable oil injections for ERD
- Assume that the same amount of substrate as with molasses will be used, but that injection events will occur less frequently because of the extended half-life (assumed to be 60 days)

Unless otherwise noted, SiteWise inputs are based on reasonable assumptions for substrate injections.

For this case study, all SiteWise inputs are entered into the "Remedial Action Operations" tab of SiteWise input sheet

For each section of SiteWise, all the sections are listed, with pertinent information added only for those sections of the input sheet where data were added.

Other calculations done outside of SiteWise are then presented. These include the following:

- % of total energy from renewable resources
- Hazardous air pollutants
- Refined material use
- Unrefined material use
- Tons of non-hazardous waste
- Tons of hazardous waste
- % of Potential Waste Recycled
- Risks to on-site works and from transportation
- Heavy truck trips through residential areas

Additional tables are attached which show how SiteWise outputs were split into "direct" and "indirect" energy use and greenhouse gas emissions. For definitions of direct and indirect energy use and emissions, please refer to section 2.2.2 of the evaluation report.

No cost calculations were attempted for this case study.

Vegetable Oil (60 Day Half-Life) – Detailed Description and SiteWise Inputs

Scope of Work

The following components are assumed for footprinting:

- Materials: Emulsified Vegetable Oil
  - Assume a half-life of 60 days
  - 500 lbs of vegetable oil used for each of 5 injection wells per event
  - 5-week injection event 1.4 times per year
  - 500 lbs per injection well * 5 wells * 1.4 events per yr = 3,500 lbs vegetable oil per yr
  - Use the following footprint conversion factors for this material:
    - Energy Use: 0.0077 MMBtu/lb
    - CO2e: 3.44 lbs CO2e/lb
    - NOx: 0.0066 lbs NOx/lb
    - SOx: 0.0019 lbs SOx/lb
    - PM: 0.000033 lbs PM/lb

    Values for rapeseed oil from Nielsen PH, Nielsen AM, Weidema BP, Dalgaard R and Halberg N (2003). LCA food data base. www.lcafood.dk. Landbrugets rådgivningscenter (2000). Tal fra Fodermiddeltabellen, Raport nr. 91. In Danish. Weidema BP (1999). System expansions to handle co-products of renewable materials. Presentation Summaries of the 7th LCA Case Studies Symposium SETAC-Europe, 1999. Pp. 45-48. pdf. Weidema B (2003). Market information in life cycle assessments. Technical report, Danish Environmental Protection Agency (Environmental Project no. 863)

- Water Use
  - Assume that for 500 lbs of vegetable oil used per injection point per event, ~3000 gallons of water will be needed to make a 2% solution, since 500 lbs vegetable oil / (8.33 lbs per gallon water * 3,000 gallons water) = 0.02
  - 3,000 gallons per injection well * 5 wells * 1.4 events per yr = 21,000 gal water per yr

- Pump Operation
  - Assume that a 5 HP transfer pump operating at 50 gpm will be required to move water needed for substrate solution. Not that this pump may be bigger or smaller than what would be needed for these injections, but since it will only be operating for a fraction of the time (i.e. not continuously year-round) that it constitutes a relatively minor footprint, and is included here mainly as an example of a remedy component that should be included in this sort of analysis.
  - 21,000 gals water used per year / 50 gpm = 420 hours of pump operation per year total.

- Personnel Transport
  - 1 person coming from 25 miles away each day during the 5-week injection periods (5 weeks * 5 days a week * 1.4 events per year = 35 round trips to the site per year)

- Materials Transport
  - Vegetable oil shipped from 200 miles away
  - 2 shipments of 1,750 lbs each per year

Vegetable Oil (60 Day Half-Life) – Detailed Description and SiteWise Inputs

Input into "Remedial Action Operations" tab of SiteWise Input Sheet.xls

- Baseline Information
  - Remedial Action Operations Cost and Duration
    - Total remedial action operations cost ($) – leave blank in SiteWise
    - Duration of remedial action operations (unit time) – 1 yr for this GSR evaluation because inputs are calculated on a yearly basis

- Material Production
  - Well Materials
  - Treatment Chemicals & Materials
  - Treatment Media
  - Construction Materials
  - Well Decommissioning
  - Bulk Material Quantities
    - The "vegetable oil" default values listed in SiteWise were not used for this analysis in order to be consistent with the footprint conversion factors used for molasses and molwhey. The following conversion factors (derived from the values listed in the Scope of Work above) were added to look up table 1c:

Material	kg CO2 e / kg	MJ /kg	MWH /kg
Material C - Vegetable Oil	**3.44E+00**	**1.79E+01**	**4.97E-03**

    - Material 1 – Yearly vegetable oil usage. Select Material C – Vegetable Oil, units in pounds, 500 lbs per well * 5 wells * 1.4 events per yr = 3,500 lbs total

- Transportation
  - Personnel Transportation – Road
    - Trip 1 – Field technician overseeing injections. Select light truck, gasoline. 50 miles round trip, 5 week injection events * 5 days a week * 1.4 events per year = 35 round trips to the site per year, 1 traveler.
  - Personnel Transportation – Air
  - Personnel Transportation – Rail
  - Equipment Transportation – Road
    - Trip 1 – Vegetable oil shipments to site. Select diesel fuel. 200 miles one way * 2 shipments per year = 400 miles traveled; 1,750 lb load / 2000 lbs per ton = 0.875 tons (per shipment).
    - Trip 2 – Empty return trips from vegetable oil delivery. Select diesel fuel. 200 miles one way * 2 empty return trips per year = 400 miles traveled; enter 0 tons for empty truck trips.
  - Equipment Transportation – Air
  - Equipment Transportation – Rail
  - Equipment Transportation – Water

- Equipment Use
  - Earthwork
  - Drilling
  - Trenching
  - Pump Operation (Electricity Region of "SPNO" is specified on "Site Info" tab of SiteWise)

        - Pump 1 – Transfer pump for moving substrate solution. Be sure to select "Method 3" from the drop-down menu at the top of the "Pump Operation" section. Then, under the "Method 3 - NAME PLATE SPECIFICATIONS ARE KNOWN" subsection, enter 5 for the HP, 1 pump, operating for 420 hours (21,000 gals water used per year / 50 gpm pumping rate).
    - Diesel and Gasoline Pumps
    - Blower, Compressor, Mixer, and Other Equipment
    - Generators
    - Agricultural Equipment
    - Capping Equipment
    - Mixing Equipment
    - Internal Combustion Engines
    - Other Fueled Equipment
    - Operator Labor
    - Laboratory Analysis
    - Other Known Onsite Activities
        - Water consumption (gallons) – 3,000 gal per well * 5 wells * 1.4 events per year = 21,000 gallons

- Residual Handling
    - Residue Disposal/Recycling
    - Landfill Operations
    - Thermal/Catalytic Oxidizers

- Resource Consumption
    - Water Consumption
    - Onsite Land and Water Resource Consumption

Once SiteWise input is complete, go to "SiteWise_Input Sheet" for overall project and enter information (including Alternative File Name "Veg Oil 60"). Then go to "Generate Alternative" tab and click button labeled "Click to generate alternative using previously entered alternative name". Copies of the input and output summary sheets for this alternative are now located in the directory titled "RA_ Veg Oil 60_NoFR_1". To store the "Remedial Action Operations.xls" calculation sheet showing detailed calculations, open it in the overall SiteWise project directory when the appropriate input sheet is open, then do a "save as" to put it in the directory for this alternative using a name that indicates "will not update". Then open that file and do "data->edit links" and break the links. If the input sheet for this alternative ever changes, then this calculation sheet needs to be re-saved.

To edit input parameters for this alternative, you must go back to the ORIGINAL SiteWise input sheet and import this alternative using the "Do you want to reload a previously saved remedial alternative in the SiteWise input sheet?" field on the "Site Info" tab. After making necessary changes to the input sheet, re-export the alternative by going to the "Generate Alternative" tab and clicking the button labeled "Click to replace an existing alternative with the same name". Update saved calculation sheets as described above.

Other Supporting Calculations:
Substrate Comparison Case Study: Vegetable Oil (60 Day Half-Life)

% of Total Energy Usage from Renewable Resources

- According to eGRID (http://cfpub.epa.gov/egridweb/index.cfm), the percentage of electricity from renewable sources for region SPNO is 0.76%. Thus, it is assumed that 0.76% of the on-site electricity use is from renewable resources. The on-site electrical use is estimated at 16.19 MMBTU in SiteWise. The total energy use (on-site and off-site) is estimated at 70.06 MMBTU. Assuming all fuels used and all other energy use for production of materials are from non-renewable sources, then the % of total energy from renewable sources is 0.0076 * (16.19 / 70.06) = 0.18%.

Hazardous Air Pollutants

- None identified

.

Refined Materials Use

- 3,500 lbs vegetable oil

Unrefined Materials Use

- None identified

Tons of Non-Hazardous Waste

- None identified

Tons of Hazardous Waste

- None identified

% of Potential Waste Recycled

- While vegetable oil is not considered a by-product, “off-spec” vegetable oil (i.e. not food-grade) could be used, which would be considered a positive from a GSR standpoint.

Risks to On-Site Workers and from Transportation

- Based on SiteWise output
    - On-Site worker injuries or fatalities = 0
    - Transportation related injuries or fatalities = 0.00162

Heavy Truck Trips through Residential Areas

- None identified

Appendix D-4

Substrate Comparison Case Study - Vegetable Oil (90 Day Half-Life)

Other Supporting Calculations:
Substrate Comparison Case Study: Vegetable Oil (60 Day Half-Life)

% of Total Energy Usage from Renewable Resources

- According to eGRID (http://cfpub.epa.gov/egridweb/index.cfm), the percentage of electricity from renewable sources for region SPNO is 0.76%. Thus, it is assumed that 0.76% of the on-site electricity use is from renewable resources. The on-site electrical use is estimated at 16.19 MMBTU in SiteWise. The total energy use (on-site and off-site) is estimated at 70.06 MMBTU. Assuming all fuels used and all other energy use for production of materials are from non-renewable sources, then the % of total energy from renewable sources is 0.0076 * (16.19 / 70.06) = 0.18%.

Hazardous Air Pollutants

- None identified

.

Refined Materials Use

- 3,500 lbs vegetable oil

Unrefined Materials Use

- None identified

Tons of Non-Hazardous Waste

- None identified

Tons of Hazardous Waste

- None identified

% of Potential Waste Recycled

- While vegetable oil is not considered a by-product, “off-spec” vegetable oil (i.e. not food-grade) could be used, which would be considered a positive from a GSR standpoint.

Risks to On-Site Workers and from Transportation

- Based on SiteWise output
    - On-Site worker injuries or fatalities = 0
    - Transportation related injuries or fatalities = 0.00162

Heavy Truck Trips through Residential Areas

- None identified

Appendix D-4
Assumptions for SiteWise Input and Other Calculations
Substrate Comparison Case Study: Vegetable Oil (90 Day Half-Life)

SiteWise "RA_Veg Oil 90_NoFR_1" Directory

For the purposes of costing and footprinting, this alternative is assumed to involve the following components:

- Emulsified vegetable oil injections for ERD
- Assume that the same amount of substrate as with molasses will be used, but that injection events will occur less frequently because of the extended half-life (assumed to be 90 days)

Unless otherwise noted, SiteWise inputs are based on reasonable assumptions for substrate injections.

For this case study, all SiteWise inputs are entered into the "Remedial Action Operations" tab of SiteWise input sheet

For each section of SiteWise, all the sections are listed, with pertinent information added only for those sections of the input sheet where data were added.

Other calculations done outside of SiteWise are then presented. These include the following:

- % of total energy from renewable resources
- Hazardous air pollutants
- Refined material use
- Unrefined material use
- Tons of non-hazardous waste
- Tons of hazardous waste
- % of Potential Waste Recycled
- Risks to on-site works and from transportation
- Heavy truck trips through residential areas

Additional tables are attached which show how SiteWise outputs were split into "direct" and "indirect" energy use and greenhouse gas emissions. For definitions of direct and indirect energy use and emissions, please refer to section 2.2.2 of the evaluation report.

No cost calculations were attempted for this case study.

Vegetable Oil (90 Day Half-Life) – Detailed Description and SiteWise Inputs

Scope of Work

The following components are considered for footprinting:

- Materials: Emulsified Vegetable Oil
    - Assume a half-life of 90 days
    - 500 lbs of vegetable oil used for each of 5 injection wells per event
    - 5-week injection event 0.9 times per year
    - 500 lbs per injection well * 5 wells * 0.9 events per yr = 2,250 lbs vegetable oil per yr
    - Use the following footprint conversion factors for this material:
        - Energy Use: 0.0077 MMBtu/lb
        - CO2e: 3.44 lbs CO2e/lb
        - NOx: 0.0066 lbs NOx/lb
        - SOx: 0.0019 lbs SOx/lb
        - PM: 0.000033 lbs PM/lb

      Values for rapeseed oil from Nielsen PH, Nielsen AM, Weidema BP, Dalgaard R and Halberg N (2003). LCA food data base. www.lcafood.dk. Landbrugets rådgivningscenter (2000). Tal fra Fodermiddeltabellen, Raport nr. 91. In Danish. Weidema BP (1999). System expansions to handle co-products of renewable materials. Presentation Summaries of the 7th LCA Case Studies Symposium SETAC-Europe, 1999. Pp. 45-48. pdf. Weidema B (2003). Market information in life cycle assessments. Technical report, Danish Environmental Protection Agency (Environmental Project no. 863)

- Water Use
    - Assume that for 500 lbs of vegetable oil used per injection point per event, ~3000 gallons of water will be needed to make a 2% solution, since 500 lbs vegetable oil / (8.33 lbs per gallon water * 3,000 gallons water) = 0.02
    - 3,000 gallons per injection well * 5 wells * 0.9 events per yr = 13,500 gal water per yr

- Pump Operation
    - Assume that a 5 HP transfer pump operating at 50 gpm will be required to move water needed for substrate solution. Not that this pump may be bigger or smaller than what would be needed for these injections, but since it will only be operating for a fraction of the time (i.e. not continuously year-round) that it constitutes a relatively minor footprint, and is included here mainly as an example of a remedy component that should be included in this sort of analysis.
    - 13,500 gals water used per year / 50 gpm = 270 hours of pump operation per year total.

- Personnel Transport
    - 1 person coming from 25 miles away each day during the 5-week injection periods (5 weeks * 5 days a week * 0.9 events per year = 22.5 round trips to the site per year)

- Materials Transport
    - Vegetable oil shipped from 200 miles away
    - 2 shipments of 1,125 lbs each per year

Vegetable Oil (90 Day Half-Life) – Detailed Description and SiteWise Inputs

Input into "Remedial Action Operations" tab of SiteWise Input Sheet.xls

- Baseline Information
  - Remedial Action Operations Cost and Duration
    - Total remedial action operations cost ($) – leave blank in SiteWise
    - Duration of remedial action operations (unit time) – 1 yr for this GSR evaluation because inputs are calculated on a yearly basis

- Material Production
  - Well Materials
  - Treatment Chemicals & Materials
  - Treatment Media
  - Construction Materials
  - Well Decommissioning
  - Bulk Material Quantities
    - The "vegetable oil" default values listed in SiteWise were not used for this analysis in order to be consistent with the footprint conversion factors used for molasses and molwhey. The following conversion factors (derived from the values listed in the Scope of Work above) were added to look up table 1c:

Material	kg CO2 e / kg	MJ /kg	MWH /kg
Material C - Vegetable Oil	**3.44E+00**	**1.79E+01**	**4.97E-03**

    - Material 1 – Yearly vegetable oil usage. Select Material C – Vegetable Oil, units in pounds, 500 lbs per well * 5 wells * 0.9 events per yr = 2,250 lbs total

- Transportation
  - Personnel Transportation – Road
    - Trip 1 – Field technician overseeing injections. Select light truck, gasoline. 50 miles round trip, 5 week injection events * 5 days a week * 0.9 events per year = 22.5 round trips to the site per year, 1 traveler.
  - Personnel Transportation – Air
  - Personnel Transportation – Rail
  - Equipment Transportation – Road
    - Trip 1 – Vegetable oil shipments to site. Select diesel fuel. 200 miles one way * 2 shipments per year = 400 miles traveled; 1,125 lb load / 2000 lbs per ton = 0.5625 tons (per shipment).
    - Trip 2 – Empty return trips from vegetable oil delivery. Select diesel fuel. 200 miles one way * 2 empty return trips per year = 400 miles traveled; enter 0 tons for empty truck trips.
  - Equipment Transportation – Air
  - Equipment Transportation – Rail
  - Equipment Transportation – Water

- Equipment Use
  - Earthwork
  - Drilling
  - Trenching
  - Pump Operation (Electricity Region of "SPNO" is specified on "Site Info" tab of SiteWise)

        - Pump 1 – Transfer pump for moving substrate solution. Be sure to select "Method 3" from the drop-down menu at the top of the "Pump Operation" section. Then, under the "Method 3 - NAME PLATE SPECIFICATIONS ARE KNOWN" subsection, enter 5 for the HP, 1 pump, operating for 270 hours (13,500 gals water used per year / 50 gpm pumping rate).
    - Diesel and Gasoline Pumps
    - Blower, Compressor, Mixer, and Other Equipment
    - Generators
    - Agricultural Equipment
    - Capping Equipment
    - Mixing Equipment
    - Internal Combustion Engines
    - Other Fueled Equipment
    - Operator Labor
    - Laboratory Analysis
    - Other Known Onsite Activities
        - Water consumption (gallons) – 3,000 gal per well * 5 wells * 0.9 events per year = 13,500 gallons

- Residual Handling
    - Residue Disposal/Recycling
    - Landfill Operations
    - Thermal/Catalytic Oxidizers

- Resource Consumption
    - Water Consumption
    - Onsite Land and Water Resource Consumption

Once SiteWise input is complete, go to "SiteWise_Input Sheet" for overall project and enter information (including Alternative File Name "Veg Oil 90"). Then go to "Generate Alternative" tab and click button labeled "Click to generate alternative using previously entered alternative name". Copies of the input and output summary sheets for this alternative are now located in the directory titled "RA_ Veg Oil 90_NoFR_1". To store the "Remedial Action Operations.xls" calculation sheet showing detailed calculations, open it in the overall SiteWise project directory when the appropriate input sheet is open, then do a "save as" to put it in the directory for this alternative using a name that indicates "will not update". Then open that file and do "data->edit links" and break the links. If the input sheet for this alternative ever changes, then this calculation sheet needs to be re-saved.

To edit input parameters for this alternative, you must go back to the ORIGINAL SiteWise input sheet and import this alternative using the "Do you want to reload a previously saved remedial alternative in the SiteWise input sheet?" field on the "Site Info" tab. After making necessary changes to the input sheet, re-export the alternative by going to the "Generate Alternative" tab and clicking the button labeled "Click to replace an existing alternative with the same name". Update saved calculation sheets as described above.

Other Supporting Calculations:
Substrate Comparison Case Study: Vegetable Oil (90 Day Half-Life)

% of Total Energy Usage from Renewable Resources

- According to eGRID (http://cfpub.epa.gov/egridweb/index.cfm), the percentage of electricity from renewable sources for region SPNO is 0.76%. Thus, it is assumed that 0.76% of the on-site electricity use is from renewable resources. The on-site electrical use is estimated at 10.41 MMBTU in SiteWise. The total energy use (on-site and off-site) is estimated at 50.28 MMBTU. Assuming all fuels used and all other energy use for production of materials are from non-renewable sources, then the % of total energy from renewable sources is 0.0076 * (10.41 / 50.28) = 0.16%.

Hazardous Air Pollutants

- None identified

.

Refined Materials Use

- 2,250 lbs vegetable oil

Unrefined Materials Use

- None identified

Tons of Non-Hazardous Waste

- None identified

Tons of Hazardous Waste

- None identified

% of Potential Waste Recycled

- While vegetable oil is not considered a by-product, "off-spec" vegetable oil (i.e. not food-grade) could be used, which would be considered a positive from a GSR standpoint.

Risks to On-Site Workers and from Transportation

- Based on SiteWise output
    - On-Site worker injuries or fatalities = 0
    - Transportation related injuries or fatalities = 0.00122

Heavy Truck Trips through Residential Areas

- None identified

Appendix D-5

Substrate Comparison Case Study - Vegetable Oil (120 Day Half-Life)

Appendix D-5
Assumptions for SiteWise Input and Other Calculations
Substrate Comparison Case Study: Vegetable Oil (120 Day Half-Life)

SiteWise "RA_Veg Oil 120_NoFR_1" Directory

For the purposes of costing and footprinting, this alternative is assumed to involve the following components:

- Emulsified vegetable oil injections for ERD
- Assume that the same amount of substrate as with molasses will be used, but that injection events will occur less frequently because of the extended half-life (assumed to be 120 days)

Unless otherwise noted, SiteWise inputs are based on reasonable assumptions for substrate injections.

For this case study, all SiteWise inputs are entered into the "Remedial Action Operations" tab of SiteWise input sheet

For each section of SiteWise, all the sections are listed, with pertinent information added only for those sections of the input sheet where data were added.

Other calculations done outside of SiteWise are then presented. These include the following:

- % of total energy from renewable resources
- Hazardous air pollutants
- Refined material use
- Unrefined material use
- Tons of non-hazardous waste
- Tons of hazardous waste
- % of Potential Waste Recycled
- Risks to on-site works and from transportation
- Heavy truck trips through residential areas

Additional tables are attached which show how SiteWise outputs were split into "direct" and "indirect" energy use and greenhouse gas emissions. For definitions of direct and indirect energy use and emissions, please refer to section 2.2.2 of the evaluation report.

No cost calculations were attempted for this case study.

Vegetable Oil (120 Day Half-Life) – Detailed Description and SiteWise Inputs

Scope of Work

The following components are considered for footprinting:

- Materials: Emulsified Vegetable Oil
  - Assume a half-life of 120 days
  - 500 lbs of vegetable oil used for each of 5 injection wells per event
  - 5-week injection event 0.7 times per year
  - 500 lbs per injection well * 5 wells * 0.7 events per yr = 1,750 lbs vegetable oil per yr
  - Use the following footprint conversion factors for this material:
    - Energy Use: 0.0077 MMBtu/lb
    - CO2e: 3.44 lbs CO2e/lb
    - NOx: 0.0066 lbs NOx/lb
    - SOx: 0.0019 lbs SOx/lb
    - PM: 0.000033 lbs PM/lb

    Values for rapeseed oil from Nielsen PH, Nielsen AM, Weidema BP, Dalgaard R and Halberg N (2003). LCA food data base. www.lcafood.dk. Landbrugets rådgivningscenter (2000). Tal fra Fodermiddeltabellen, Raport nr. 91. In Danish. Weidema BP (1999). System expansions to handle co-products of renewable materials. Presentation Summaries of the 7th LCA Case Studies Symposium SETAC-Europe, 1999. Pp. 45-48. pdf. Weidema B (2003). Market information in life cycle assessments. Technical report, Danish Environmental Protection Agency (Environmental Project no. 863)

- Water Use
  - Assume that for 500 lbs of vegetable oil used per injection point per event, ~3000 gallons of water will be needed to make a 2% solution, since 500 lbs vegetable oil / (8.33 lbs per gallon water * 3,000 gallons water) = 0.02
  - 3,000 gallons per injection well * 5 wells * 0.7 events per yr = 10,500 gal water per yr

- Pump Operation
  - Assume that a 5 HP transfer pump operating at 50 gpm will be required to move water needed for substrate solution. Not that this pump may be bigger or smaller than what would be needed for these injections, but since it will only be operating for a fraction of the time (i.e. not continuously year-round) that it constitutes a relatively minor footprint, and is included here mainly as an example of a remedy component that should be included in this sort of analysis.
  - 10,500 gals water used per year / 50 gpm = 210 hours of pump operation per year total.

- Personnel Transport
  - 1 person coming from 25 miles away each day during the 5-week injection periods (5 weeks * 5 days a week * 0.7 events per year = 17.5 round trips to the site per year)

- Materials Transport
  - Vegetable oil shipped from 200 miles away
  - 2 shipments of 875 lbs each per year

Vegetable Oil (120 Day Half-Life) – Detailed Description and SiteWise Inputs

Input into "Remedial Action Operations" tab of SiteWise Input Sheet.xls

- Baseline Information
  - Remedial Action Operations Cost and Duration
    - Total remedial action operations cost ($) – leave blank in SiteWise
    - Duration of remedial action operations (unit time) – 1 yr for this GSR evaluation because inputs are calculated on a yearly basis

- Material Production
  - Well Materials
  - Treatment Chemicals & Materials
  - Treatment Media
  - Construction Materials
  - Well Decommissioning
  - Bulk Material Quantities
    - The "vegetable oil" default values listed in SiteWise were not used for this analysis in order to be consistent with the footprint conversion factors used for molasses and molwhey. The following conversion factors (derived from the values listed in the Scope of Work above) were added to look up table 1c:

Material	kg CO2 e / kg	MJ /kg	MWH /kg
Material C - Vegetable Oil	3.44E+00	1.79E+01	4.97E-03

    - Material 1 – Yearly vegetable oil usage. Select Material C – Vegetable Oil, units in pounds, 500 lbs per well * 5 wells * 0.7 events per yr = 1,750 lbs total

- Transportation
  - Personnel Transportation – Road
    - Trip 1 – Field technician overseeing injections. Select light truck, gasoline. 50 miles round trip, 5 week injection events * 5 days a week * 0.7 events per year = 17.5 round trips to the site per year, 1 traveler.
  - Personnel Transportation – Air
  - Personnel Transportation – Rail
  - Equipment Transportation – Road
    - Trip 1 – Vegetable oil shipments to site. Select diesel fuel. 200 miles one way * 2 shipments per year = 400 miles traveled; 875 lb load / 2000 lbs per ton = 0.4375 tons (per shipment).
    - Trip 2 – Empty return trips from vegetable oil delivery. Select diesel fuel. 200 miles one way * 2 empty return trips per year = 400 miles traveled; enter 0 tons for empty truck trips.
  - Equipment Transportation – Air
  - Equipment Transportation – Rail
  - Equipment Transportation – Water

- Equipment Use
  - Earthwork
  - Drilling
  - Trenching
  - Pump Operation (Electricity Region of "SPNO" is specified on "Site Info" tab of SiteWise)

        - Pump 1 – Transfer pump for moving substrate solution. Be sure to select “Method 3” from the drop-down menu at the top of the “Pump Operation” section. Then, under the “Method 3 - NAME PLATE SPECIFICATIONS ARE KNOWN” subsection, enter 5 for the HP, 1 pump, operating for 210 hours (10,500 gals water used per year / 50 gpm pumping rate).
    - Diesel and Gasoline Pumps
    - Blower, Compressor, Mixer, and Other Equipment
    - Generators
    - Agricultural Equipment
    - Capping Equipment
    - Mixing Equipment
    - Internal Combustion Engines
    - Other Fueled Equipment
    - Operator Labor
    - Laboratory Analysis
    - Other Known Onsite Activities
        - Water consumption (gallons) – 3,000 gal per well * 5 wells * 0.7 events per year = 10,500 gallons

- Residual Handling
    - Residue Disposal/Recycling
    - Landfill Operations
    - Thermal/Catalytic Oxidizers

- Resource Consumption
    - Water Consumption
    - Onsite Land and Water Resource Consumption

Once SiteWise input is complete, go to “SiteWise_Input Sheet” for overall project and enter information (including Alternative File Name “Veg Oil 120”). Then go to “Generate Alternative” tab and click button labeled “Click to generate alternative using previously entered alternative name”. Copies of the input and output summary sheets for this alternative are now located in the directory titled “RA_ Veg Oil 120_NoFR_1”. To store the “Remedial Action Operations.xls” calculation sheet showing detailed calculations, open it in the overall SiteWise project directory when the appropriate input sheet is open, then do a “save as” to put it in the directory for this alternative using a name that indicates “will not update”. Then open that file and do “data->edit links” and break the links. If the input sheet for this alternative ever changes, then this calculation sheet needs to be re-saved.

To edit input parameters for this alternative, you must go back to the ORIGINAL SiteWise input sheet and import this alternative using the “Do you want to reload a previously saved remedial alternative in the SiteWise input sheet?” field on the “Site Info” tab. After making necessary changes to the input sheet, re-export the alternative by going to the “Generate Alternative” tab and clicking the button labeled “Click to replace an existing alternative with the same name”. Update saved calculation sheets as described above.

Other Supporting Calculations:
Substrate Comparison Case Study: Vegetable Oil (120 Day Half-Life)

% of Total Energy Usage from Renewable Resources

- According to eGRID (http://cfpub.epa.gov/egridweb/index.cfm), the percentage of electricity from renewable sources for region SPNO is 0.76%. Thus, it is assumed that 0.76% of the on-site electricity use is from renewable resources. The on-site electrical use is estimated at 8.10 MMBTU in SiteWise. The total energy use (on-site and off-site) is estimated at 42.37 MMBTU. Assuming all fuels used and all other energy use for production of materials are from non-renewable sources, then the % of total energy from renewable sources is 0.0076 * (8.10 / 42.37) = 0.15%.

Hazardous Air Pollutants

- None identified

.

Refined Materials Use

- 1,750 lbs vegetable oil

Unrefined Materials Use

- None identified

Tons of Non-Hazardous Waste

- None identified

Tons of Hazardous Waste

- None identified

% of Potential Waste Recycled

- While vegetable oil is not considered a by-product, “off-spec” vegetable oil (i.e. not food-grade) could be used, which would be considered a positive from a GSR standpoint.

Risks to On-Site Workers and from Transportation

- Based on SiteWise output
  - On-Site worker injuries or fatalities = 0
  - Transportation related injuries or fatalities = 0.00106

Heavy Truck Trips through Residential Areas

- None identified

REVISED FINAL REPORT

PILOT PROJECT
GREEN AND SUSTAINABLE REMEDIATION EVALUATION: FORMER LOCKBOURNE AIR FORCE BASE LANDFILL

Prepared for:

U.S. Army Corps of Engineers
Environmental and Munitions Center of Expertise
1616 Capitol Ave, Suite 9200
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Contract No. W912DQ-08-D-0019
Delivery Order No. ZW02

Prepared by:

Tetra Tech EC, Inc.
1000 American Rd.
Morris Plains, NJ 07950

3 May 2011
Revised 20 June 2011

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List of Appendices

PREFACE

The US Army Engineering and Support Center, Huntsville (USAESCH), Environmental and Munitions Center of Expertise (EM CX) has contracted Tetra Tech EC, Inc. (Tetra Tech) under Contract W912DQ-08-D-0019, Delivery Order No. ZW02, to conduct and document a Study that follows the process of considering, incorporating, documenting, and evaluating the benefits of green and sustainable remediation (GSR) practices. The objective of this Task Order is to: (1) Follow the consideration and incorporation of GSR practices into Army environmental remediation projects; (2) Ascertain the effectiveness of the GSR practices that are considered and incorporated; and (3) Provide procedures by which GSR practices that are shown to be effective can be identified, considered, implemented and documented by Project Teams working on Army sites. The information obtained from this Study will be used to provide recommendations to the Office of the Assistant Chief of Staff for Installation Management (OACSIM) for development of Army-wide GSR guidance and policy. This document has been prepared in accordance with the Task Order Statement of Work (SOW) entitled "*Evaluation of Consideration and Incorporation of Green and Sustainable Remediation (GSR) Practices in Army Environmental Remediation*" (26 July 2010).

The Project Delivery Team (PDT) consists of representatives and subject matter experts (SMEs) from the following organizations:

- EM CX;
- OACSIM;
- National Guard Bureau (NGB);
- Army Environmental Command (AEC);
- Tetra Tech;
- Office of the Deputy Assistant Secretary of the Army-Environment, Safety, and Occupational Health (ODASA (ESOH));
- Headquarters US Army Corps of Engineers (HQ USACE) Formerly Used Defense Sites (FUDS) program;
- HQ USACE Environmental Community of Practice (ECoP) Military Munitions Support Services (M2S2);
- Huntsville Center Environmental Program; and
- Army Environmental Policy Institute (AEPI)

Specific representatives of those organizations are listed on the table at the end of this preface. This report pertains to one of the pilot projects conducted as part of the Study. Tetra Tech personnel who provided the most significant contributions to this report are as follows:

- Preparation
    - Doug Sutton (IRP GSR Technical Lead)
    - Sarah Farron

- Review
    - Rob Greenwald (Project Manager)

Sincere thanks are extended to Project Team associated with this pilot project, for their willingness to participate in this Study and for their efforts that were associated with their participation.

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Professional in Charge:

Doug Sutton, PhD, PE, LEED

_____6/20/11_____
Date

ACRONYMS AND ABBREVIATIONS

ACSIM	Assistant Chief of Staff for Installation Management
AEC	Army Environmental Command
AEPI	Army Environmental Policy Institute
AFB	Air Force Base
ANG	Air National Guard
AOC	Area of Concern
BMPs	Best Management Practices
BoD	Basis of Design
CO2	Carbon dioxide
CO2e	Equivalent Global Warming Potential of Carbon Dioxide
CRAA	Columbus Regional Airport Authority
CSM	Conceptual Site Model
DD	Decision Document
DoD	Department of Defense
ECoP	Environmental Community of Practice
EM CX	Environmental and Munitions Center of Expertise
ERA	Ecological Risk Assessment
ESOH	Environment, Safety, and Occupational Health
FFS	Focused Feasibility Study
FUDS	Formerly Used Defense Sites
GHG	Greenhouse gas
GSR	Green and Sustainable Remediation
HHRA	Human Health Risk Assessment
HQ USACE	Headquarters US Army Corps of Engineers
HRS	Hours
IRP	Installation Restoration Program
Kg	Kilograms
lbs	Pounds
LTM	Long Term Monitoring
M2S2	Military Munitions Support Services
MMBtu	Million Metric British Thermal Units
MMRP	Military Munitions Response Program
NGB	National Guard Bureau
NOx	Nitrogen Oxides
NPV	Net present value
O&M	Operations and Maintenance
OACSIM	Office of the Assistant Chief of Staff for Installation Management
ODASA	Office of the Deputy Assistant Secretary of the Army
P&T	Pump and Treat
PAHs	Polynuclear Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls
PDT	Project Delivery Team
PM	Particulate Matter
POTW	Publicly Operated Treatment Works
RANGB	Rickenbacker Air National Guard Base
RECs	Renewable Energy Certificates
RI	Remedial Investigation
SiteWise	Battelle SiteWise™ Sustainable Environmental Remediation Tool

SMEs	Subject matter experts
SOW	Statement of Work
SOx	Sulfur Oxides
US	United States
USACE	United States Army Corps of Engineers
USAESCH	US Army Engineering and Support Center, Huntsville
VFD	Variable Frequency Drive

1.0 INTRODUCTION

1.1 ACSIM GSR STUDY AND PURPOSE OF THIS GSR EVALUATION

The US Army Engineering and Support Center, Huntsville (USAESCH), Environmental and Munitions Center of Expertise (EM CX) has contracted Tetra Tech EC, Inc. (Tetra Tech) under Contract W912DQ-08-D-0019, Delivery Order No. ZW02, to conduct and document a Study that follows the process of considering, incorporating, documenting, and evaluating the benefits of green and sustainable remediation (GSR) practices (hereafter referred to as "the Study"). Pursuant to the Department of Defense (DoD) Memorandum "*Consideration of Green and Sustainable Remediation Practices in the Defense Environmental Restoration Program*" (DoD, 2009), GSR employs strategies throughout the remedial process that:

- Use natural resources and energy efficiently;
- Reduce negative impacts on the environment;
- Minimize or eliminate pollution at its source;
- Protect and benefit the community at large; and
- Reduce waste to the greatest extent possible.

The objective of the Study is to: (1) Follow the consideration and incorporation of GSR practices into Army environmental remediation projects; (2) Ascertain the effectiveness of the GSR practices that are considered and incorporated; and (3) Provide procedures by which GSR practices that are shown to be effective can be identified, considered, implemented and documented by project teams working on Army sites. The information obtained from this Study will be used to provide recommendations to the Office of the Assistant Chief of Staff for Installation Management (OACSIM) for development of Army-wide GSR guidance and policy.

One component of the Study described above is to perform a GSR evaluation at 12 Army "Pilot Projects" that are in various phases of the remedial process. This report presents the Pilot Project GSR Evaluation for the Lockbourne Landfill at the Former Air Force Base, Lockbourne, OH (hereafter referred to as "Lockbourne Landfill"). This GSR evaluation has been conducted using an approach developed during the Study and documented in the following report: *Process for Consideration and Incorporation of Green and Sustainable Remediation (GSR) Practices in Army Environmental Remediation (draft final dated 9 February 2011).* One purpose for the pilot projects is to provide testing of the GSR approach developed during the Study. That approach will be refined and finalized later in the Study based on lessons learned from this and other pilot projects. In addition, it is anticipated that this GSR evaluation will provide the Project Team for Lockbourne Landfill with information and/or recommendations that will be beneficial for their project.

This report refers to "teams" that are defined as follows:

- Study Team: This is the team conducting the Study being led by USACE EM CX that follows the process of considering, incorporating, documenting, and evaluating the benefits of green and sustainable remediation practices for Army projects.

- Project Team: Refers to those associated with implementation of the remedial process for the pilot projects.

- GSR Team: Refers to the personnel that perform a specific GSR evaluation. For this Study, the GSR Team consists of personnel from Tetra Tech, which is a contractor to USACE for the Study.

In this Study, an "EM CX liaison" for each of the pilot projects serves as a bridge between the USACE Study project manager (Carol Dona), the Study contractor performing the GSR evaluation (Tetra Tech), and the Project Team manager for the specific pilot. For this pilot project the EM CX Liaison is Carol Dona, with additional support from Sam Bass.

1.2 TECHNICAL OVERVIEW: LOCKBOURNE LANDFILL

1.2.1 <u>Overview of Site Location, Setting, and Contamination</u>

The Site is located east of Interstate 71 in Franklin County, just east of the village of Lockbourne, Ohio. The former AFB encompassed over 4,000 acres and is now occupied by the Columbus Regional Airport Authority (CRAA), the Rickenbacker Air National Guard Base (RANGB), Naval Reserve, and various retail and service businesses. The landfill extends over approximately 145 acres of undeveloped area located west of the developed portion of the former AFB, on land that is presently owned by the CRAA. The former landfill was used to dispose of wastes generated at the former base. There are two investigation areas: Area of Concern (AOC) 1 and AOC 2 (see Figure 1-1). AOC 1 is approximately 105 acres and occupies the western half of the parcel where waste disposal occurred. AOC 2 is approximately 40 acres and is located on the eastern side of the site. Although there is scattered inert debris at the site, no buried waste was found at AOC 2 during test pitting activities. AOC 2 was separated from AOC 1 during the remedial investigation (RI) process with the intent of expediting re-use of this portion of the site.

Surface drainage is controlled through storm drains, which include corrugated metal and concrete drainage pipes, and open drainage ditches. The West Ditch and East Ditch are located adjacent to the former landfill (see Figure 1-1). Surface water ultimately discharges to Big Walnut Creek (beyond extent of Figure 1-1).

Contaminants including, but not limited to, polynuclear aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), dioxins/furans, and metals have been detected in soil, surface water, sediment, and groundwater on or near the landfill. The following summary was provided in the Draft Final FFS by CH2M HILL:

> *A human health risk assessment (HHRA) was performed during the RI to evaluate potential current and future risks associated with detected constituents at the Former Lockbourne AFB Landfill site. Unacceptable risk was found in soil and groundwater in AOC 1, and in groundwater for AOC 2…An ecological risk assessment (ERA) was performed at AOC 1 and 2 to evaluate potential current and future risks associated with detected constituents at these AOCs. The ERA also evaluated ditches located along the eastern and western portions of the site as separate exposure areas. Potential ecological risks were identified at the site. Specifically, risks were identified for terrestrial mammals and birds at AOC 1 and to lower-trophic receptors at AOC 1, the East Ditch, and the West Ditch. No unacceptable risk was identified for ecological receptors at AOC 2.*

Remedial activities are being designed and implemented to mitigate unacceptable threats to human health and the environment.

1.2.2 Remedial Phase and Status

Between 1986 and 2008, several investigations were conducted by the USEPA and USACE to evaluate environmental contamination at the site. The May 2010 RI by CH2M HILL summarizes these investigative activities and presents an interpretation and evaluation of the available data. A Draft Final Focused Feasibility Study (FFS) Report, dated December 2010, documents the development and evaluation of remedial action alternatives for landfill closure.

The preferred alternative, which involves consolidation of waste, construction of a soil cover, long term monitoring, and institutional controls, is currently in the design phase. The Draft Final FFS provided a conceptual description of the preferred alternative, which included an approximate 40 acre soil cap. The 30% Basis of Design (BoD) Report, dated February 2011, was provided to the GSR Team (referred to herein as the "30% Design"). The 30% Design has included additional effort to refine the remedy concept described in the FFS, and currently includes a capped area of approximately 24.7 acres and a minimum 4% slope in all directions. This reportedly will result in a mound of approximately 15 ft. The area where waste will be excavated for consolidation will allow for unrestricted industrial/commercial re-use. In the capped area, land use will be further restricted to not allow any penetration.

The 60% Design Report is currently scheduled for 18 April 2011. This GSR evaluation was conducted based on information provided in the 30% Design Report as well as information presented at a 2 March 2011 design meeting held at the site. It was stated during this meeting that the 30% Design Report represents design information as of 28 February 2011. It should also be noted that the 30% Design Report provided prior to the 2 March 2011 meeting was in draft form, and did not include some elements typically included in a 30% design submittal primarily due to the expedited schedule for this project. The schedule of the GSR evaluation was also expedited so that the Project Team would receive the Draft GSR Report early enough to allow sufficient time for GSR findings or recommendations to potentially be included within the 60% Design.

This GSR evaluation provides an evaluation of the selected alternative with respect to specific GSR metrics, and also highlights how specific GSR Best Management Practices (BMPs) have been implemented in previous remedial activities and/or could be implemented during design and construction. However, this GSR evaluation does not in any manner include an evaluation or judgment of the protectiveness of the selected alternative.

1.3 DOCUMENTS REVIEWED AND CALLS/MEETINGS CONDUCTED

The following project documents were reviewed for this evaluation:

- *Draft 30% Basis of Design Report* (CH2M HILL, February 2011)
- *Draft Final Focused Feasibility Study* (CH2M HILL, December 2010)
- *Remedial Investigation Report* (CH2M HILL, May 2010)

As per the GSR approach being implemented in the Study, an introductory conference call (referred to as the "Step 3" call) was conducted on 25 January 2011. Items discussed on this call included the following:

- The schedule of the GSR evaluation was discussed within the context of how the GSR evaluation could best be integrated into the overall efforts and schedule of the Project Team.

- The subsequent "Step 5" call, which would serve as a primary mechanism for the GSR Team and Project Team to exchange information and ideas, was scheduled for 2 March 2011. Following the "Step 3" call, it was determined that the GSR team would conduct a site visit and attend a design meeting onsite on 2 March 2011 in place of the "Step 5" call. Meeting attendees also included members of the Study Team, members of the Project Team and design consultants, Ohio EPA regulators, and a representative for Rickenbacker Airport.

Participants for the "Step 3" call are listed in Table 1-1.

Table 1-1
Step 3 Call Participants, 25 January 2011

Participants			
Name	**Organization**	**Phone**	**Email**
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A site tour was conducted on 1 March 2011 and the design meeting and discussion of GSR considerations took place on 2 March 2011. During this meeting the GSR Team used the list of GSR BMPs developed for the Study as an outline to ask questions to the Project Team and allow the Project Team to provide pertinent information to the GSR Team. For this pilot project, the GSR team was also provided with a list of GSR BMPs compiled and evaluated prior to the 2 March 2011 meeting by CH2M HILL (the Project Team consultant). Participants for this meeting are listed in Table 1-2.

Table 1-2
Step 5 Meeting Participants, 2 March 2011

Participants			
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1.4 STRUCTURE OF THIS REPORT

This GSR evaluation report is structured as follows:

- Section 1: Introduction
- Section 2: Key GSR Findings
  - Review of BMPs
  - Quantitative Footprint Analysis for Consolidation and Capping (Current Design)
  - Other Qualitative Considerations
- Section 3: GSR Recommendations

Supporting information and calculations for quantitative aspects of the evaluation are provided in appendices, and spreadsheet files for the SiteWise tool are attached electronically.

2.0 KEY GSR FINDINGS

2.1 REVIEW OF BEST MANAGEMENT PRACTICES (BMPs)

2.1.1 BMP Tables Completed by GSR Team

The GSR Team and the Project Team used a list of GSR BMPs as an outline to exchange information and ideas pertinent to application of GSR practices for this pilot project. The GSR Team subsequently completed the BMP tables included in Appendix A, based on the data provided by the Project Team in the form of documents as well as discussions during the Step 5 meeting and site visit. Table 2-1 summarizes information entered on the BMP tables in Appendix A, specifically with respect to the number of BMPs that appear to be applicable for this pilot project, the number of BMPs that appear to be practical for this pilot project, the number of BMPs that have been implemented prior to this GSR evaluation, and the number of BMPs that maybe associated with potential cost savings for this pilot project.

Table 2-1
Summary of BMP Applicability and Implementation from BMP Tables in Appendix A

	BMP Category								
	A. Planning	B. Characterization and/or Remedy Approach	C. Energy/Emissions Transportation	D. Energy/Emissions Equipment Use	E. Materials & Off-site Services	F. Water Resource Use	G. Waste Generation, Disposal, and Recycling	H. Land Use, Ecosystems, and Cultural Resources	I. Safety and Community
Total Number of BMPs	10	9	4	11	5	5	6	7	7
Number of Applicable BMPs	10	7	3	2	3	4	3	5	4
Number of Practical BMPs	10	6	2	0	3	0	2	3	3
Number of BMPs Implemented Prior to GSR Evaluation									
- Fully	8	5	2	0	2	0	1	2	1
- Partially	2	0	0	0	1	0	0	1	0
- Not Yet	0	1	0	0	0	0	1	0	2
Number of Practical BMPs Likely to Result in Cost Savings	3	5	2	0	3	0	1	0	2

2.1.2 Key Findings Regarding BMPs

An overview of key findings regarding application of the BMPs to this pilot project is provided below.

- The Project Team has already compiled a list of their own BMPs and conducted a thorough review of which of those BMPs could potentially be applicable for this project. Thus, the Project Team has already considered many of the GSR BMPs included in Appendix A. Examples of GSR BMPs already considered or incorporated include (but are not limited to) the following:

    - Identifying stakeholder concerns regarding GSR issues, such as CRAA's preferences regarding future land use and the State's preference to return surface water to natural conditions.

    - Aligning schedules to minimize mobilization and equipment use (e.g., addressing the concrete structure on the West Ditch at the same time as the landfill consolidation and capping).

    - Developing a dynamic approach for assessing the presence of waste during remedial action construction to limit the extent of excavation (also, the design team stated they would reduce landfill slopes rather than the landfill footprint if less waste is encountered during consolidation, which could lead to a wider variety of potential reuse options).

    - Leaving in place structures whose removal is not necessary (e.g., stumps in area to be covered, and possibly part of the concrete structure if determined to help with cap stability).

    - Minimizing transportation of personnel (carpooling, teleconferences, staying at same hotels, etc.) and trying to limit the need to transport materials from off-site (e.g., obtaining soil cover material from on-site) as well as limiting transport of wastes off-site (e.g., considering all ways to use mulch from vegetation clearing as part of the remedy construction).

    - Balancing future land use considerations by allowing for multiple re-use options (e.g., unrestricted commercial/industrial use in the excavated areas and with more limited use in the capped areas). For example, solar panels for electricity generation is a potential future use of the capped area if designed with non-penetrating (i.e., ballasted) supports.

    - Minimizing materials usage such as by grading the on-site borrow area rather than refilling it (also precluding the need for materials from off-site).

    - Minimizing disturbance to land (e.g., designing so that vegetation on AOC 2 does not need to be disturbed).

    - Documenting ecologically sensitive populations (e.g., wetlands areas, Indiana Bat habitat) prior to construction.

    - Minimizing contact with dangerous materials, by designing so the capped area is where the previous waste disposal was more intensive and the consolidation area is where the waste disposal was least intensive).

- While going through the BMP list at the Step 5 meeting, the GSR Team suggested several items that the Project Team could consider moving forward. Some examples include the following:

  - Submitting appendices and lab reports for future deliverables electronically to save paper and perhaps shipping.

  - Considering use of whole-water or no-purge samplers such as HydraSleeves™ rather than low flow sampling to reduce or eliminate purge water from sampling, since purge water must be disposed of as investigation derived waste.

  - Considering use of existing structures during construction for temporary office space (e.g., the old transmitter building or vacant airport offices) if feasible.

- The Project Team identified that some BMPs are not practical to implement because of other project-specific constraints. Examples include the following:

  - Purchasing Renewable Energy Certificates (RECs) to offset footprints associated with electricity usage is not considered to be practical because it increases costs. RECs can be purchased on the open market as an added cost for electricity, and are used by the seller to finance construction of renewable energy projects. The purchaser of the RECs obtains the right to claim the credit for the emissions offsets provided by that renewable energy. In all cases, however, purchasing RECs results in increased costs, and since this is a FUDS project, minimizing cost is seen as a higher priority than purchasing offsets.

  - Re-using the capped area for wind energy would likely compromise the cap (would require structures that pierce the cap, which the Project Team indicated was not desirable) and is likely not feasible given the proximity to an active airport runway. Using the capped area for crops (e.g., biodiesel) would likely cause negative impacts related to sediment and fertilizer runoff at the storm water drainage ditch.

- Some BMPs are potentially applicable in a future remedial phase, but it is somewhat premature to consider them in detail during the Design Phase. Some examples include the following:

  - Developing an approach to minimize engine idle times.

  - Using alternate fuel options, such as biodiesel, for construction equipment.

2.2 QUANTITATIVE FOOTPRINT ANALYSIS FOR CONSOLIDATION AND CAPPING (CURRENT DESIGN)

2.2.1 Overview of Consolidation and Capping

The preferred alternative will be used as a baseline in this evaluation, and it involves the following components (see Figure 2-1 for layout):

- Clearing and grubbing of existing vegetation (no grubbing in capped area)
- Stripping and stockpiling of existing topsoil
- Excavating waste in the non-capped area and consolidating waste within the area to be covered

- Rough grading of the landfill surface in preparation for constructing the soil cover using consolidated waste materials
- Constructing a soil cover consisting of a 24 inch compacted soil layer, overlain with 6 inches of cover material suitable for establishing and supporting the vegetation selected for the cover
- Restoring waste excavation and onsite borrow source areas
- Implementing a passive gas venting system
- Implementing long-term operations and maintenance (O&M) measures to ensure the protectiveness of the cover
- Installing a drainage swale
- Defining a monitoring well network
- Implementing the environmental covenants to restrict use to industrial/commercial activities, prohibit intrusive activities on the landfill cover, and restrict the use of site groundwater

Input to the SiteWise tool and other supporting calculations are described in Appendix B.

2.2.2 Summary of Quantitative Footprint Results, Consolidation and Capping

Table 2-2 summarizes the quantitative footprint results for the preferred alternative. Input to the SiteWise tool and other supporting calculations are described in Appendix B. The SiteWise files utilized for this portion of the analysis are supplied electronically ("Alternative 1").

Table 2-2 divides total energy use and global warming potential into "direct" and "indirect" use and emissions. The following definitions are utilized for "direct" versus "indirect" energy use and global warming potential:

- Direct Scope 1: From sources that are owned or controlled by the reporting entity.
- Indirect Scope 2: Due to activities of the reporting entity, but occur at sources owned or controlled by another entity, from consumption of purchased electricity, heat or steam.
- Indirect Scope 3: Due to activities of the reporting entity, but occur at sources owned or controlled by another entity, other than Scope 2 (such as the extraction and production of purchased materials and fuels, transport-related activities in vehicles not owned or controlled by the reporting entity, outsourced activities, waste disposal, etc.

SiteWise reports total energy use and total global warming potential, but does not sum the "direct" and "indirect" components. The user needs to track the distinction between "direct" and "indirect" components separately, based on information contained within the SiteWise spreadsheets. The separation of the total energy and global warming potential is documented in Appendix B, which describes SiteWise input and related calculations.

Table 2-2
Summary of Quantitative Footprint for Consolidation and Capping (Current Design)

GSR Parameter	Unit	Value
Environmental		
Energy – Total	MMBtu	13,553
Energy – Direct Scope 1	MMBtu	10,547
Energy – Indirect Scope 2	MMBtu	0
Energy – Indirect Scope 3	MMBtu	3,006
% of Energy from Renewable Resources	%	0
Global warming potential – Total	Metric tons CO2e	875
Global warming potential – Direct Scope 1	Metric tons CO2e	671
Global warming potential – Indirect Scope 2	Metric tons CO2e	0
Global warming potential – Indirect Scope 3	Metric tons CO2e	203
Criteria air pollutant emissions	Metric tons (NOx+SOx+PM)	6.4
Hazardous air pollutant emissions	Lb	0
Potable water use	1,000s of gallons	not quantified(1)
Other water use	1,000s of gallons	not quantified(1)
Refined materials use	Lbs	7,992
% of refined materials from recycled material	%	none
Unrefined materials use	Ton	none identified
% of unrefined materials from recycled material	%	N/A
Non-hazardous waste generation	Ton	negligible
Hazardous waste generation	Ton	none
% of potential waste that is recycled or re-used	%	100%(2)
Land transferred or made available for beneficial use	Acres	106
Existing ecosystem destruction	Acres	not quantified
Time frame for land re-use	Years	2
Flexibility and breadth of options for re-use	see below	1
Economic		
Life-cycle Cost, Discounted (2.7% discount rate)	$	$7.98 million
Life-cycle Cost, Undiscounted	$	$9.01 million
Up-front Cost	$	$5.49 million
Societal		
Predicted number of injuries or fatalities for On-Site Worker	Number of injuries or fatalities	0.09
Predicted number of injuries or fatalities associated with transportation	Number of injuries or fatalities	0.02
One-Way Heavy Vehicle Trips through Res. Area	Trips	76

**Scale for flexibility and breadth of re-use options (greater GSR value with lower number, indicating more breadth and flexibility for potential re-use)*

1 - Unlimited re-use options
2 - Limited re-use options
3 - Only one re-use option

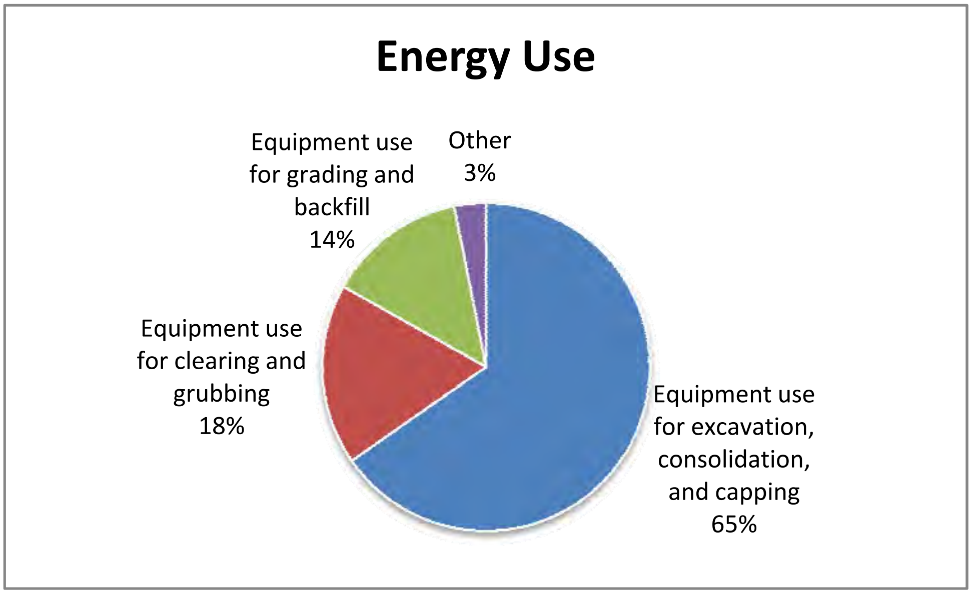
(1) *Water use is primarily going to be for dust suppression and soil cover compaction. This could be obtained from surface water or from groundwater well, which has not yet been determined. For now, this has been left as not quantified. Other water use pertains to development water for new wells and purge water for sampling of monitoring wells which is considered to be very minor in the overall scope of the remedy.*

(2) *The major potential source of waste requiring offsite disposal is the mulch that will be generated. For this evaluation it is assumed that other uses for mulch will be developed as part of the remedy such that 100% of the waste will be recycled.*

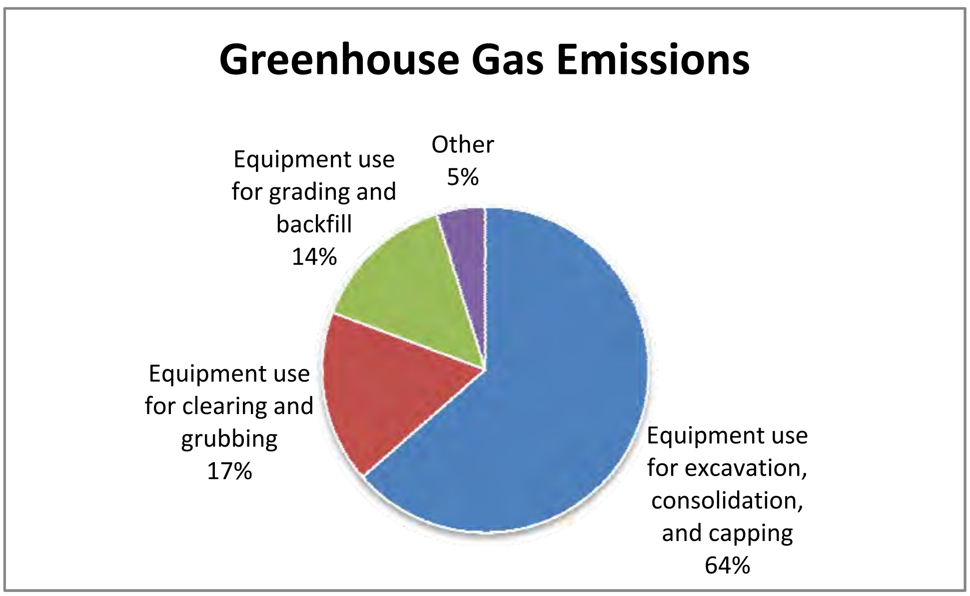
2.2.3 Key Findings from Quantitative Footprint Analysis, Consolidation and Capping

Observations and finding based on the quantitative footprinting results from SiteWise include the following:

- The primary contributors of the energy use is due to equipment use, which is broken out by construction phase as follows (based on percentage of total energy use):



- The primary contributors of the greenhouse gas emissions is also due to equipment use, which is broken out by construction phase as follows (based on percentage of total CO_2e):



- Approximately 75% of the energy use and greenhouse gas emissions is “Direct Scope 1”, which is driven by the on-site use of machinery for the excavation, consolidation, and capping.

- Methane and carbon dioxide from the passive gas vents are not included in calculation of greenhouse gases. Although some passive gas vents will be installed, previous sampling has indicated low-levels of methane consistent with natural conditions, and the project team believes that the waste is not a significant source of methane. The footprinting assumes that any methane released through the passive vents is natural and would be released with or without the remedy, and therefore is not specifically quantified.

- Equipment use also dominates the NOx, SOx, and PM in similar percentages as energy use and CO2e.

- There is no electricity associated with this remedy, which is why equipment use dominates the parameters discussed above.

- Transportation of personnel for the entire remedial action represents approximately 2% of the energy used, and approximately 3% of the total CO2e emitted. Thus, during remediation activities there will be more benefit in trying to reduce energy use and emissions due to equipment use rather than optimizing personnel transportation.

- Table 2-2 indicates that 106 acres will be made available for beneficial re-use. This is the amount of acres associated with AOC 1. Although the capped area (24.7 acres) will have more restrictions than the rest of AOC 1, all of the acreage can potentially be used for beneficial purposes after the remedy is completed.

- The total number of injuries/fatalities calculated by SiteWise is low (approximately 0.1 over the course of the remedy), and the calculated risk is greater for equipment use (82%) than for transportation (18%).

2.3 OTHER QUALITATIVE CONSIDERATIONS

For this GSR evaluation, a number of considerations were discussed during the 2 March 2011 design meeting. These discussions highlighted the considerable attention this Project Team has given to GSR considerations, which for this project tend to be qualitative in nature. For instance, the configuration of the cap and excavation areas in the current design also eliminates any need to disturb AOC 2, thus minimizing disturbance to a heavily forested area until that area is placed into other use by the landowner. The Project Team is also trying to strike a balance between grades (for drainage), borrow volumes, and excavation volumes so as to minimize cost and also minimize usage of machinery for transporting soil (which reduces energy use, safety risk, etc.). Another item discussed during the design meeting on 2 March 2011 was the disposition of large slabs of asphalt or concrete that might be excavated. The GSR Team asked if it would be beneficial to segregate such items for potential re-use elsewhere. The Project Team indicated that they felt the segregation process would require so much more labor, sampling, and use of machinery that it would not represent a net benefit. In addition, they suggested that approach could delay the schedule, and also stated they might need the material in the capped area to achieve the desired grade. Also, the Project Team indicated that optimization of groundwater and passive gas monitoring will be performed after a five-year baseline is established, with the potential for reduced sampling frequency, analytical parameters, and/or locations. This illustrates that GSR concepts are being actively evaluated by the Project Team.

Some of the GSR issues discussed during the 2 March 2011 design meeting merit further consideration as the design process continues, including the following:

- With respect to removal of the concrete structure on West Ditch, the State preferences regarding returning streams to their natural state are being considered. However, the Project Team indicated that those concerns should be balanced with potential negative impacts associated with complete removal of the concrete structure, which could include undermining the stability of the capped area and/or increasing erosion potential. In addition, complete removal will require more machinery use, create more waste, and may require more temporary disruption to the current stream. The 60% Design should likely include a detailed evaluation of the pros and cons of complete versus partial removal of the concrete structure so that an optimal balance of these technical and GSR consideration is achieved.

- In the area that will be covered, clearing will be performed, but grubbing (i.e. below the surface) will not be performed. Stumps will be left in place and waste will be placed around them. This is a green practice because it reduces equipment usage, and potentially requires less soil to be transferred from the borrow area. However, some technical issues were raised by the project team that should be evaluated further, such as the potential for decaying stumps to cause preferential settlement, to create preferred pathways for leachate migration, and/or to provide preferential slip pathways that could inhibit slope stability. These technical considerations should be addressed before proceeding with this otherwise green approach.

- Kevin Mieczkowski (USACE) suggested during the meeting on 2 March 2011 that it might be a good idea during construction to dig out an area near existing surface water in the vicinity of the borrow area to allow pooling of water that could be accessed for water needs such as dust control. That area could subsequently serve as flood control and/or a wetlands area.

- Significant mulch will be generated as a result of clearing during the remedy. Kevin Mieczkowski (USACE) suggested during the 2 March 2011 meeting that a portion of the mulch can be utilized by mixing a portion of woodchips in with smaller cut woodchips, seeded with "landfill mix", and fertilized to create appropriate grass on top of the cap. Alternatively, the mulch could possibly be traded for topsoil from a local composting facility, or used for dust suppression and/or roads. The 60% Design should more fully evaluate some of the potential onsite uses for mulch from the areas cleared during the remedy implementation.

3.0 GSR RECOMMENDATIONS

These are recommendations provided by the GSR Team for the consideration of the Project Team, and potentially other project stakeholders. These are not requirements, and implementation should ultimately be decided by the Project Team based on their concurrence regarding GSR benefits and/or other project-specific constraints.

GSR recommendations are summarized in the form of tracking tables, as follows:

Table Number	Recommendation
3-1	3.1 - Evaluate the pros and cons of complete versus partial removal of the concrete structure
3-2	3.2 - Determine if there are technical issues that would preclude leaving stumps in place in the area that will be covered
3-3	3.3 - Evaluate the idea to dig out an area to allow pooling of surface water for use during construction
3-4	3.4 - Perform a detailed technical and feasibility evaluation to maximize potential use of mulch generated by vegetation clearing for other aspects of the remedial construction
3-5	3.5 – Evaluate use of whole-water or no-purge samplers such as HydraSleeve™ for groundwater sampling, to eliminate or reduce purge water
3-6	3.6 – Evaluate potential alternatives for dust control

The tracking table format allows the implementation status of the recommendation to be updated as the project progresses.

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Table 3-1
Tracking Table for Recommendation 3.1

<table>
<tr><td colspan="2" rowspan="2">Recommendation:

3.1 - Evaluate the pros and cons of complete versus partial removal of the concrete structure</td><td>Current Date:
5/3/11</td></tr>
<tr><td>Date of Original Recommendation:
5/3/11</td></tr>
<tr><td colspan="3">Basis for Recommendation (Include discussion of cost impacts and value if appropriate):

With respect to removal of the concrete structure on West Ditch, the State preferences regarding returning streams to their natural state are being considered. However, the Project Team indicated that those concerns should be balanced with potential negative impacts associated with complete removal of the concrete structure, which could include undermining the stability of the capped area and/or increasing erosion potential. In addition, complete removal will require more machinery use, create more waste, and may require more temporary disruption to the current stream. The 60% Design should likely include a detailed evaluation of the pros and cons of complete versus partial removal of the concrete structure so that an optimal balance of these technical and GSR consideration is achieved. Associated permit modifications and regulatory coordination should be considered.</td></tr>
<tr><td colspan="3">Resources Conserved:
☐ Hazardous air pollutants ☐ GHG emissions (CO2e) ☐ Energy ☐ Water ☐ Waste
☐ Criteria pollutants ☐ Safety/Community ☐ Materials ☐ Land-use</td></tr>
<tr><td>Qualitative Net Cost Impact Over 5 Years, No Discounting

☐ Cost Increase ☐ Cost Savings
☐ Cost Neutral ☐ N/A</td><td colspan="2">☐ Recommended action otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="3">Attachment(s) to report with footprint assumptions and calculations:

Not applicable. This recommendation is based on qualitative considerations, and there are no meaningful quantitative footprint calculations to be made at this point.</td></tr>
<tr><td>Implementation Status:

☐ Fully
☐ Partially
☒ Not Yet
☐ Not Planned</td><td colspan="2">Explanation of Status:

This is a new recommendation for the Project Team to consider for the 60% Design.

The purpose of the recommendation is to evaluate in more detail than has been done to date if it is better to completely remove the concrete structure or to leave part of it in place. Depending on the results of that analysis, costs may increase or decrease and different GSR parameters (other than cost) may be positively or negatively impacted. For that reason, the boxes above are not checked.</td></tr>
</table>

Table 3-2
Tracking Table for Recommendation 3.2

Recommendation: *3.2 - Determine if there are technical issues that would preclude leaving stumps in place in the area that will be covered*	Current Date: 5/3/11 Date of Original Recommendation: 5/3/11
Basis for Recommendation (Include discussion of cost impacts and value if appropriate): *In the area that will be covered, clearing will be performed, but grubbing (i.e. below the surface) will not be performed. Stumps will be left in place and waste will be placed around them. This is a green practice because it reduces equipment usage, and potentially requires less soil to be transferred from the borrow area. However, some technical issues were raised by the Project Team that should be evaluated further, such as the potential for decaying stumps to cause preferential settlement, to create preferred pathways for leachate migration, and/or to provide preferential slip pathways that could inhibit slope stability. These technical considerations should be addressed before proceeding with this otherwise green approach.*	
Resources Conserved: [ ] Hazardous air pollutants [ ] GHG emissions (CO2e) [ ] Energy [ ] Water [ ] Waste [ ] Criteria pollutants [ ] Safety/Community [ ] Materials [ ] Land-use	
Qualitative Net Cost Impact Over 5 Years, No Discounting [ ] Cost Increase [ ] Cost Savings [X] Cost Neutral [ ] N/A	[ ] Recommended action otherwise required? If checked, required by:
Level of Up-Front Investment Included in 5 Year Cost Impact: [X] Negligible [ ] < $10,000 [ ] $10,001 - $50,000 [ ] $50,001 - $100,000 [ ] $100,001 - $500,000 [ ] > $500,000	
Attachment(s) to report with footprint assumptions and calculations: *Not applicable. This recommendation is based on qualitative considerations, and there are no meaningful quantitative footprint calculations to be made at this point.*	
Implementation Status: [ ] Fully [ ] Partially [X] Not Yet [ ] Not Planned	Explanation of Status: *This is a new recommendation for the Project Team to consider for the 60% Design.* *The GSR Team notes that leaving the stumps in place is the current plan of the Project Team, and concurs that this is more favorable with respect to GSR considerations than removing the stumps. The purpose of this recommendation is to encourage detailed evaluation regarding potential technical issues that were raised in the 2 March 2011 meeting. The "resources conserved" boxes above are not checked based on an assumption that it will be determined that the stubs will be left in place (i.e., status quo), and the cost boxes are checked accordingly. However, if the stubs need to be removed, various GSR parameters would be negatively impacted and costs would increase.*

Table 3-3
Tracking Table for Recommendation 3.3

<table>
<tr><td colspan="3" rowspan="2">Recommendation:

3.3 - Evaluate the idea to dig out an area to allow pooling of surface water for use during construction</td><td>Current Date:
5/3/11</td></tr>
<tr><td>Date of Original Recommendation:
5/3/11</td></tr>
<tr><td colspan="4">Basis for Recommendation (Include discussion of cost impacts and value if appropriate):

Kevin Mieczkowski (USACE) suggested during the meeting on 2 March 2011 that it might be a good idea during construction to dig out an area near existing surface water in the vicinity of the borrow area to allow pooling of water that could be accessed for water needs such as dust control. That area could subsequently serve as flood control and/or a wetlands area.</td></tr>
<tr><td colspan="4">Resources Conserved:
☐ Hazardous air pollutants ☐ GHG emissions (CO2e) ☐ Energy ☒ Water ☐ Waste
☐ Criteria pollutants ☐ Safety/Community ☐ Materials ☐ Land-use</td></tr>
<tr><td colspan="2">Qualitative Net Cost Impact Over 5 Years, No Discounting

☐ Cost Increase ☐ Cost Savings
☒ Cost Neutral ☐ N/A</td><td colspan="2">☐ Recommended action otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="4">Attachment(s) to report with footprint assumptions and calculations:

Not applicable. This is based on qualitative considerations, and no calculations were performed.</td></tr>
<tr><td>Implementation Status:

☐ Fully
☐ Partially
☒ Not Yet
☐ Not Planned</td><td colspan="3">Explanation of Status:

This is a new recommendation for the Project Team to consider for the 60% Design.

This would potentially eliminate the need to obtain water via groundwater wells for use as dust control and/or for cover compaction. The boxes above regarding cost assume the overall impact to project cost would be negligible given that the construction equipment would already be mobilized and available and that any additional design/construction costs would be offset if the need for other sources of water is precluded.</td></tr>
</table>

Table 3-4
Tracking Table for Recommendation 3.4

<table>
<tr><td colspan="2">Recommendation:

3.4 - Perform a detailed technical and feasibility evaluation to maximize potential use of mulch generated by vegetation clearing for other aspects of the remedial construction</td><td>Current Date:
5/3/11
Date of Original Recommendation:
5/3/11</td></tr>
<tr><td colspan="3">Basis for Recommendation (Include discussion of cost impacts and value if appropriate):

Significant mulch will be generated as a result of clearing during the remedy. Kevin Mieczkowski (USACE) suggested during the 2 March 2011 meeting that a portion of the mulch can be utilized by mixing a portion of woodchips in with smaller cut woodchips, seeded with "landfill mix", and fertilized to create appropriate grass on top of the cap. Alternatively, the mulch could possibly be traded for topsoil from a local composting facility, or used for dust suppression and/or roads. The 60% Design should more fully evaluate some of the potential onsite uses for mulch from the areas cleared during the remedy implementation.</td></tr>
<tr><td colspan="3">Resources Conserved:
☒ Hazardous air pollutants ☒ GHG emissions (CO2e) ☒ Energy ☒ Water ☒ Waste
☒ Criteria pollutants ☒ Safety/Community ☒ Materials ☐ Land-use</td></tr>
<tr><td>Qualitative Net Cost Impact Over 5 Years, No Discounting

☐ Cost Increase ☒ Cost Savings
☐ Cost Neutral ☐ N/A</td><td colspan="2">☐ Recommended action otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="3">Attachment(s) to report with footprint assumptions and calculations:

Not applicable. There are too many potential options and too much uncertainty to perform meaningful calculations.</td></tr>
<tr><td>Implementation Status:

☐ Fully
☐ Partially
☒ Not Yet
☐ Not Planned</td><td colspan="2">Explanation of Status:

This is a new recommendation for the Project Team to consider for the 60% Design.

The boxes above are checked because any incremental decrease in the amount of mulch that needs to be sent off-site will generally be positive with respect to GSR considerations (i.e., less transport, less potential waste disposal, etc.). We are assuming negligible up-front cost for using the mulch on-site relative to any costs that would be incurred for transporting/disposing the mulch off-site.</td></tr>
</table>

Table 3-5
Tracking Table for Recommendation 3.5

Recommendation:	Current Date:
3.5 - Evaluate use of whole-water or no-purge samplers such as HydraSleeve™ for groundwater sampling, to eliminate or reduce purge water	5/3/11 Date of Original Recommendation: 5/3/11

Basis for Recommendation (Include discussion of cost impacts and value if appropriate):

Sam Bass mentioned during the meeting on 2 March 2011 that the use of HydraSleeves™ for groundwater sampling would eliminate (or reduce) the need for purge water to be handled and disposed. Use of whole-water samplers would also allow sample collection where it otherwise may not be feasible due to low well yield. Also, changing to passive whole-water samplers at this point in the project (design / pre-construction) would allow potential comparability issues to be addressed prior to going into long-term monitoring. Use of whole-water samplers may conserve resources (materials) typically used for low-flow sampling (e.g., nitrogen gas supply or a compressor and generator (or battery), decontamination supplies, etc). There are repeated costs associated with purchasing the samplers, but these are typically offset by savings in labor and elimination of investigative-derived waste. There may be some resource tradeoffs due to the potential need to make two trips to the site to collect a passive sample (once to install the sampler and once to retrieve it). It is recommended that the Project Team evaluate if this sampling approach is technically appropriate for this site.

Resources Conserved:
☐ Hazardous air pollutants ☐ GHG emissions (CO2e) ☐ Energy ☒ Water ☒ Waste
☐ Criteria pollutants ☐ Safety/Community ☒ Materials ☐ Land-use

Qualitative Net Cost Impact Over 5 Years, No Discounting	
☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A	☐ Recommended action otherwise required? If checked, required by:

Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Attachment(s) to report with footprint assumptions and calculations:

Not applicable. This recommendation is based on qualitative considerations, and no calculations were performed.

Implementation Status:	Explanation of Status:
☐ Fully ☐ Partially ☒ Not Yet ☐ Not Planned	*This is a new recommendation for the Project Team to consider for the 60% Design.*

Table 3-6
Tracking Table for Recommendation 3.6

<table>
<tr><td colspan="2" rowspan="2">Recommendation:

3.6 - Evaluate potential alternatives for dust control</td><td>Current Date:
5/3/11</td></tr>
<tr><td>Date of Original Recommendation:
5/3/11</td></tr>
<tr><td colspan="3">Basis for Recommendation (Include discussion of cost impacts and value if appropriate):

During the meeting on 2 March, 2011, a number of possible alternatives for dust control were discussed. A portion of the West Ditch could be excavated to allow for pooling of water, or surface water could be collected in excavated pond areas. Rain water could be captured to augment water from other sources. Mulch generated on-site could also be used for dust suppression. It is recommended that the Project Team further evaluate the potential alternatives for dust control as the design continues.</td></tr>
<tr><td colspan="3">Resources Conserved:
☐ Hazardous air pollutants ☐ GHG emissions (CO2e) ☐ Energy ☒ Water ☐ Waste
☐ Criteria pollutants ☒ Safety/Community ☐ Materials ☐ Land-use</td></tr>
<tr><td colspan="2">Qualitative Net Cost Impact Over 5 Years, No Discounting

☐ Cost Increase ☒ Cost Savings
☐ Cost Neutral ☐ N/A</td><td>☐ Recommended action otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="3">Attachment(s) to report with footprint assumptions and calculations:

Not applicable. This recommendation is based on qualitative considerations, and no calculations were performed.</td></tr>
<tr><td>Implementation Status:

☐ Fully
☐ Partially
☒ Not Yet
☐ Not Planned</td><td colspan="2">Explanation of Status:

This is a new recommendation for the Project Team to consider for the 60% Design.</td></tr>
</table>

FIGURES

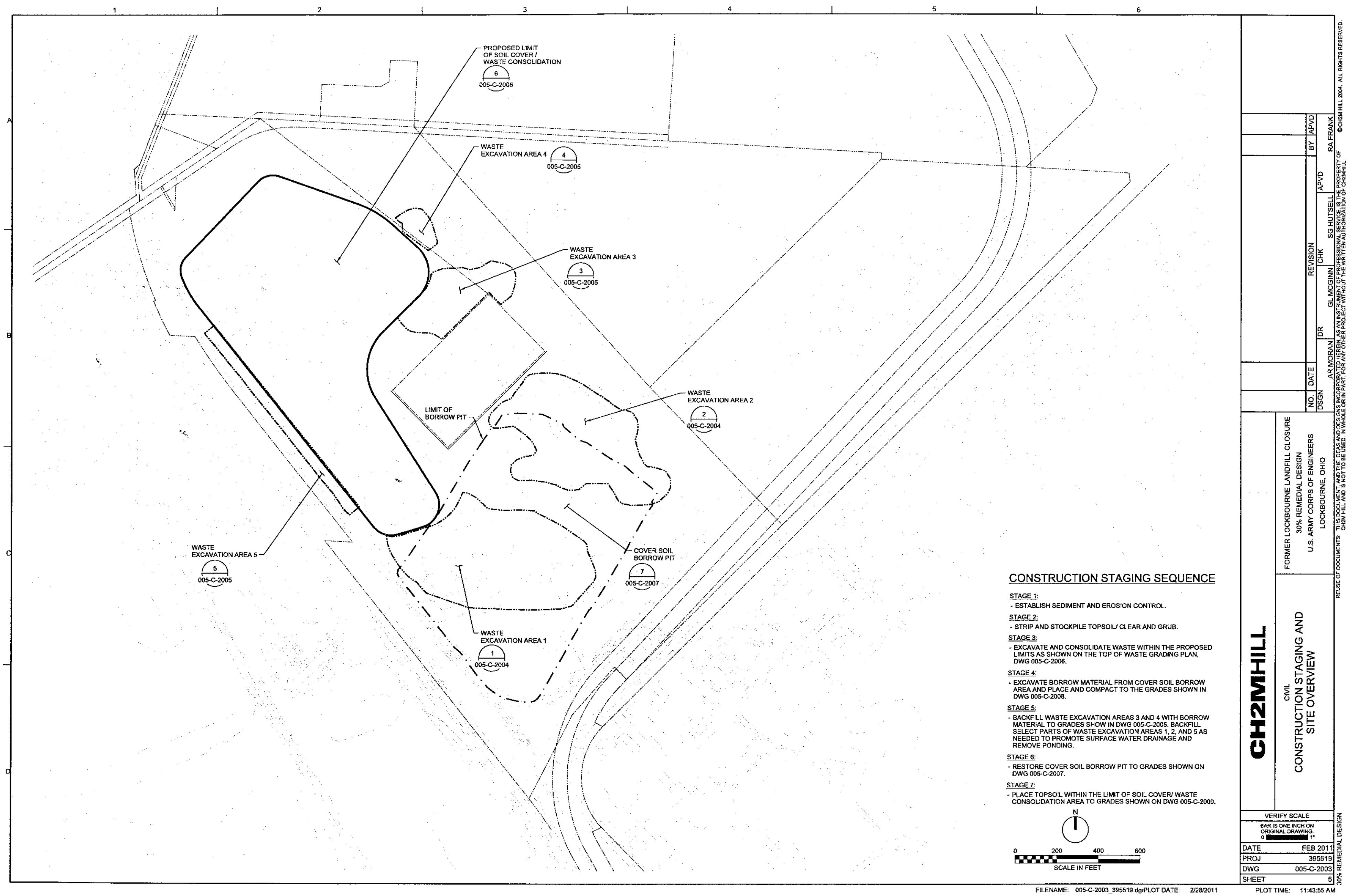
Figure 1-1: Site Features Map

FIGURE 1-2
Site Features Map
Focused Feasibility Study Report
Former Lockbourne Air Force Base Landfill

CH2MHILL.

From Figure 1-2 of Draft Final FFS by CH2M HILL

Figure 2-1: Layout of Preferred Alternative



From Sheet 5 of 30% Remedial Design by CH2M HILL

APPENDIX A

Best Management Practice (BMP) Tables

BMP A-1: Develop a culture of GSR within the Project Team and encourage GSR ideas from project staff

Date: 5/3/11

☒ Applicable

☒ Evaluated

☒ Practical

Implemented?
("N/A" if "Practical" not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☒ Economic ☒ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☒ Hazardous air pollutants ☒ Energy ☒ Waste
☒ Criteria pollutants ☒ Materials ☒ Safety/Community
☒ GHG emissions (CO2e) ☒ Water ☒ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

The Project Team's participation in this Study indicates an interest in GSR considerations. The Project Team has considered GSR practices during their design process, and CH2M HILL has compiled an extensive list of BMPs and assessed their applicability for this site. GSR considerations began at end of RI phase, and were included in monthly meeting discussions and contract scope of work for the remedial design.

BMP A-2: Incorporate a section on GSR in project meetings, work plans, and reports

Date: 5/3/11

☒ Applicable

☒ Evaluated

☒ Practical

Implemented?
("N/A" if "Practical" not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☒ Economic ☒ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☒ Hazardous air pollutants ☒ Energy ☒ Waste
☒ Criteria pollutants ☒ Materials ☒ Safety/Community
☒ GHG emissions (CO2e) ☒ Water ☒ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

The 30% Design Report contains a placeholder for a GSR section, and the 60% Design Report will contain a complete section on GSR. A portion of the design meeting held on 2 March 2011 was also dedicated to discussing GSR considerations.

BMP Category A: Planning

<table>
<tr><td colspan="3">BMP A-3: Identify and periodically update a list of key stakeholders and their concerns with respect to GSR considerations</td><td>Date: 5/3/11
☒ Applicable
☒ Evaluated
☒ Practical</td></tr>
<tr><td>Implemented?
("N/A" if "Practical" not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☒ Economic ☒ Social</td><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="2">Resources Conserved:
☒ Hazardous air pollutants ☒ Energy ☒ Waste
☒ Criteria pollutants ☒ Materials ☒ Safety/Community
☒ GHG emissions (CO2e) ☒ Water ☒ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

The CRAA (i.e., the airport) has been asked for their ideas regarding many GSR considerations, such as potential for overall land use in the vicinity, specific potential land use in the area to be excavated and the area to be capped, and regarding the removal of the concrete structure on West Ditch.

The State preferences regarding returning streams to their natural state are being considered with respect to the concrete structure removal on West Ditch.</td></tr>
</table>

<table>
<tr><td colspan="3">BMP A-4: Schedule activities for appropriate seasons and/or time of day to reduce delays caused by weather conditions and fuel needed for heating or cooling
Examples:
- Work at night in summer to avoid heat stress
- Perform field activities in summer to take advantage of longer daylight</td><td>Date: 5/3/11
☒ Applicable
☒ Evaluated
☒ Practical</td></tr>
<tr><td>Implemented?
("N/A" if "Practical" not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
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<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
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<tr><td colspan="2">Resources Conserved:
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☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

Current plans for remedy implementation involve an aggressive schedule, but some consideration has been given to scheduling activities for the appropriate season. Clearing is currently scheduled to begin in spring of 2012, however, if the Indiana Bat is present, then the Project Team indicated that clearing of the required areas would have to be conducted between September and March, and the Project Team would therefore begin clearing in fall 2011 under those circumstances.

The seasonality discussed above pertains to minimizing ecosystem disturbance rather than conserving a resource. The GSR Team has no specific basis for determining if clearing is more expensive if it has to be done starting in fall 2011 (due to the Indiana Bat) rather than spring 2012, as currently planned.</td></tr>
</table>

BMP Category A: Planning

BMP A-5: Prepare, store, and distribute documents electronically	**Date:** 5/3/11 ☒ Applicable ☒ Evaluated ☒ Practical

Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☒ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☐ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Reports for this project are distributed in both hard copy and electronic forms. The GSR Team suggested that lab data and other appendices be distributed on disk instead of hard copies, and the Project Team agreed that this would be a good practice.

BMP A-6: Utilize teleconferences rather than meetings when feasible	**Date:** 5/3/11 ☒ Applicable ☒ Evaluated ☒ Practical

Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Teleconferencing is utilized as much as possible. However, there are benefits to conducting certain meetings in person when feasible.

BMP A-7: Incorporate green specifications into solicitations and contracts Examples: - Follow pertinent green procurement policies - Select hotel chains with "green" policies - Select laboratories that utilize renewable energy	**Date:** 5/3/11 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☒ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☒ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *CH2M HILL has done some preliminary work and identified 18 of their own BMPs that could be included as GSR specifications. GSR is also included in the scope of work for design activities.*	

BMP A-8: Integrate schedules to allow for resource sharing and fewer days of field mobilization	**Date:** 5/3/11 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☐ Waste ☒ Criteria pollutants ☐ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *An effort will be made to schedule equipment use at the same time and avoid multiple mobilizations. For example, removal of the concrete structure will be done at the same time as landfill capping so that the same equipment can be used.*	

<table>
<tr><td colspan="2">BMP A-9: Explore multiple site re-use options, including those that include some restriction of site re-use and related resource conservation</td><td>Date: 5/3/11
☒ Applicable
☒ Evaluated
☒ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A</td><td colspan="2">Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
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If checked, required by:</td></tr>
<tr><td colspan="3">Notes (including discussion of possible value of implementing the BMP):

Site re-use is not a stated part of the remedy, but the airport has expressed interest in some variety of beneficial re-use where appropriate. Numerous possibilities have been considered, some of which include low profile wind turbines, solar panels, recreational area, and additional parking lots. Solar placed on ballasted (i.e. non-penetrating) structures may be a leading candidate for the capped area because of other restrictions. Consolidation will minimize the size of the capped portion, which will increase the amount of land available for unrestricted commercial/industrial re-use.</td></tr>
</table>

<table>
<tr><td colspan="2">BMP A-10: Conduct thorough review of project documents and historical records to minimize required scope of investigation
Examples:
- IRP projects: determine if there are previous aquifer tests that can be used for groundwater modeling rather than conducting new aquifer tests
- MMRP projects: perform careful review of historic documents, aerial photographs, and other existing information to reduce the footprint of land that needs to be disturbed for thorough investigation and remediation
- MMRP projects: use IRP sampling data to supplement and enhance the MMRP field program (if available)</td><td>Date: 5/3/11
☒ Applicable
☒ Evaluated
☒ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A</td><td colspan="2">Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
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☒ GHG emissions (CO2e) ☒ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Notes (including discussion of possible value of implementing the BMP):

Aerial photos and historic geophysical data have been used for site characterization. However, a topographic survey will need to be done due to potential inconsistencies with older aerial photos. In addition, there are limited geotechnical data for soil in AOC 1, particularly in the borrow area, so further soil sampling in that area will be required prior to use for the soil cap.</td></tr>
</table>

BMP Category B: Characterization and/or Remedy Approach

BMP B-1: Develop and routinely update a conceptual site model (CSM) to use as a basis for making remedial process decisions	**Date:** 5/3/11 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☒ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *The CSM continues to be updated routinely. The cost and up-front investment regarding GSR are hard to quantify.*	

BMP B-2: Perform frequent optimization evaluations to improve efficiency of current or planned actions and/or develop alternative remedial approaches that might shorten remedy duration or otherwise improve the net environmental benefit of the remedy	**Date:** 5/3/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP is less applicable to this site than would be the case for an active, ongoing system. Potential for LTM optimization on both the groundwater and landfill gas will be evaluated at the time of the 5-year review.*	

BMP Category B: Characterization and/or Remedy Approach

<table>
<tr><td colspan="3">BMP B-3: Use appropriate characterization or remedy approach based on site conditions
Examples:
- Consider in-situ and passive remedy options that offer adequate protectiveness
- Consider in-situ bioremediation if conditions are already anaerobic and constituents are conducive to reductive dechlorination
- Compare source removal versus in-situ and ex-situ remedial options
- Consider different technologies for impacted areas with higher and lower concentrations
- Use realistic times to remedy closeout (i.e., estimations through modeling) rather than assumed remedy timeframes (e.g., 30 years), which is often used for evaluation of FS alternatives
- MMRP projects: evaluate man-portable DGM instruments versus vehicle-towed array (VTA) instruments and inclusion of detector-aided reconnaissance (DAR)</td><td>Date: 5/3/11

☒ Applicable
☒ Evaluated
☒ Practical</td></tr>
<tr><td>Implemented?
("N/A" if "Practical" not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
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<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
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<tr><td colspan="2">Resources Conserved:
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☒ Criteria pollutants ☒ Materials ☒ Safety/Community
☒ GHG emissions (CO2e) ☒ Water ☒ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

A prescriptive remedy for landfills (capping) is being used at this site, and the cap is only being placed over the "heavily used" area. In addition, a soil cap is being used rather than a clay cap because the primary purpose is preventing exposure rather than infiltration. The Project Team indicated that they will develop an optimal sampling approach for soil to be taken from the borrow area, which may involve multi-increment sampling.</td></tr>
</table>

BMP Category B: Characterization and/or Remedy Approach

<table>
<tr><td colspan="2">BMP B-4: Establish decision points to trigger a change from one technology to another or from one remedy alternative to another
Examples:
- Change vapor treatment from thermal oxidation to granular activated carbon (GAC) media based on flow rates and concentrations
- Remove a treatment polishing step if influent to that step already meets discharge criteria
- Move to Monitored Natural Attenuation (MNA) if specific concentration thresholds in groundwater are met</td><td>Date: 5/3/11

☒ Applicable
☒ Evaluated
☒ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A</td><td colspan="2">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
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<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
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☒ GHG emissions (CO2e) ☒ Water ☒ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Notes (including discussion of possible value of implementing the BMP):

An alternate approach for the soil cap will be used if the 1e⁻⁶ cm/sec permeability for the 24-inch soil cap is not fully attained. If the soil from the local borrow area (which rates highly for GSR due to short transport distance) cannot fully meet this criterion, the project team has developed a backup based on HELP modeling to use 12 inches of 1e⁻⁷ cm/sec covered by 18 inches of 1e⁻⁴ to 1e⁻⁵ cm/sec, which they are confident will be available and which they state will provide equivalent protectiveness. A decision tree for LTM will be included in the 60% Design Report.

The design team stated they would reduce landfill slopes rather than the landfill footprint if less waste is encountered during consolidation. This could lead to a wider variety of potential reuse options.</td></tr>
</table>

BMP Category B: Characterization and/or Remedy Approach

BMP B-5: Focus sampling efforts to meet objectives of the specific remedial phase (e.g., sampling during O&M should be focused on evaluating remedy performance and not on thorough plume characterization)

Examples:

- Eliminate sampling parameters as appropriate
- Reduce sampling frequency as appropriate
- Reduce sample locations as appropriate
- Enhance monitoring program as appropriate
- MMRP projects: consider Incremental Sampling Methodology (ISM) versus discrete sampling for MC characterization

Date: 5/3/11

☒ Applicable

☐ Evaluated

☐ Practical

Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☒ Economic ☒ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☒ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☒ Hazardous air pollutants ☒ Energy ☒ Waste
☒ Criteria pollutants ☒ Materials ☒ Safety/Community
☒ GHG emissions (CO2e) ☒ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Decisions about which monitoring wells will be sampled will be made in the 60% Design. Sampling has not been performed regularly for the past 6 years, and wells will need to be redeveloped before sampling takes place. Low-flow sampling will be used, but the state of Ohio requires purge water to be disposed of offsite as investigation-derived waste. As an alternative to low-flow sampling, the use of whole-water or no-purge samplers such as HydraSleeve™ for groundwater sampling, to eliminate or reduce purge water for sample collection, should be evaluated to minimize or eliminate waste. The Project Team indicated that the initial sampling frequency of quarterly for two years followed by semi-annual for 3 years is to establish baseline data and trends and that an LTM plan will lay out a decision for subsequently reducing sampling frequency. This BMP is applicable, but the LTM program has not yet been fully evaluated by the Project Team to this point. The Project Team is also trying to minimize (or eliminate) explosive gas monitoring.

BMP B-6: Consider real-time measurements and dynamic work plans to reduce mobilizations and improve effectiveness of investigation efforts Examples: - Field test kits (e.g., test kits for sulfate) - Field screening instruments (e.g., x-ray fluorescence for lead or photoionization detectors for volatile organics) - Drive point sensor technologies (e.g., membrane interface probe or "MIP") - Visual staining or odor - Establish excavation extent based on real-time data collected as excavation proceeds and use GPS to accurately delineate excavation areas - MMRP projects: use GPS and/or the same equipment that was used for detection to confirm anomaly signatures prior to excavating - MMRP projects: consider incorporating field screening methods (e.g., X-ray fluorescence, EXPRAY and explosives test kits, as appropriate or applicable) into the field program to refine sampling locations and reduce the quantities of samples submitted for off-site laboratory analysis	**Date:** 5/3/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Addressed for this project in BMP B-8.*	

BMP B-7: Consider use of existing site structures/infrastructure or mobilization of temporary structures versus new construction
Examples:
- Buildings (e.g., for treatment building or field office)
- Concrete slabs or foundations
- Wells
- Existing excavations for storm water control

Date: 5/3/11

☒ Applicable

☒ Evaluated

☒ Practical

Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☒ Not Yet ☐ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☒ Economic ☒ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
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☒ Criteria pollutants ☒ Materials ☒ Safety/Community
☒ GHG emissions (CO2e) ☒ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

The existing monitoring wells will be used to the extent possible. This will be outlined in greater detail in the 60% Design Report.

Part of the concrete structure in West Ditch could be left in place for stability of the soil cap.

The old transmitter building could be used instead of a trailer during construction if it is not demolished. Alternatively, an available CRAA building could be used.

BMP B-8: Establish project-specific decision points to limit extent of remediation
Examples:
- Project-specific cleanup levels based on a site-specific risk assessment (coordinated with risk assessment experts) rather than generic cleanup levels, if it results in lower footprints for key parameters and is acceptable to all stakeholders
- MMRP projects: dig stopping rules and anomaly prioritization/detection criteria to minimize false positives

Date: 5/3/11

☒ Applicable

☒ Evaluated

☒ Practical

Implemented?
("N/A" if "Practical" not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☐ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
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☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

During landfill consolidation, the presence of waste (both laterally and vertically) will be verified by visual assessment in order to determine the extent of excavation. This will prevent excessive digging in areas with little waste.

Industrial/commercial screening levels and site-established background levels will be used rather than generic criteria for metals.

BMP Category B: Characterization and/or Remedy Approach

<table>
<tr><td colspan="2">BMP B-9: Consider leaving in place structures whose removal is not necessary (i.e., foundations, underground pillars, etc.)</td><td>Date: 5/3/11
☒ Applicable
☒ Evaluated
☒ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A</td><td colspan="2">Qualitative Net Cost Impact Over 5 Years, No Discounting
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☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☐ Economic ☐ Social</td><td colspan="2">Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td>Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Notes (including discussion of possible value of implementing the BMP):

The sidewalls of the concrete structure on West Ditch could be left in place for soil cap stability.

The current gravel road will be left in place to provide access to the site.

In the area that will be covered, clearing will be performed, but grubbing (i.e. below the surface) will not be performed. Stumps will be left in place and waste will be placed around them. This is a green practice because it reduces equipment usage, and potentially requires less soil to be transferred from the borrow area. However, some technical issues were raised by the project team that should be evaluated further, such as the potential for decaying stumps to cause preferential settlement, to create preferred pathways for leachate migration, and/or to provide preferential slip pathways that could inhibit slope stability. These technical considerations should be addressed before proceeding with this otherwise green approach.</td></tr>
</table>

BMP Category C: Energy/Emissions – Transportation

BMP C-1: Reduce the number of trips for personnel Examples: - Encourage carpooling - Use telemetry systems and webcams to remotely transmit data directly to project offices to avoid trips	**Date:** 5/3/11 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? (“N/A” if “Practical” not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☐ Waste ☒ Criteria pollutants ☐ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Members of the Project Team make an effort to stay in the same hotel and carpool for site visits.*	

BMP C-2: Reduce the number of trips and/or volume for transported materials, equipment, or waste Examples: - Transfer full loads by consolidating shipments from vendors and/or shipments to disposal sites (also share shipments with neighbors if feasible) - Purchase more concentrated chemicals to reduce transportation weight and/or volume	**Date:** 5/3/11 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? (“N/A” if “Practical” not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☐ Waste ☒ Criteria pollutants ☐ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *During construction, there will be significant transport of soil, and it is assumed that the number of trips will be minimized out of economic considerations.* *Potential reduction of trips due to use of mulch on-site.*	

BMP Category C: Energy/Emissions – Transportation

BMP C-3: Reduce trip lengths Examples: - Dispose of waste at closest appropriate facility - Purchase materials, equipment, and services from local vendors - Use locally produced supplies - Select most efficient transportation route	**Date:** 5/3/11 ☒ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

An attempt will be made to find a potential onsite use for the mulch generated by vegetation clearing, to minimize the need to transport the mulch offsite. Otherwise, nearby offsite uses are being evaluated.

It has not yet been determined where the contractor for sampling would come from, but an attempt should be made to use a local contractor if possible.

BMP C-4: Use alternate fuels or other options for transportation when possible Examples: - Compressed natural gas - Biodiesel blends - Ethanol blends - Hybrid and/or electric - Rail lines versus trucks - Use a fuel efficient passenger car rather than a pickup truck if task allows	**Date:** 5/3/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Most of the fuel use will be for on-site equipment use, which is addressed in BMP D-3.

BMP Category D: Energy/Emissions – Equipment Use

BMP D-1: Consider and implement approaches to minimize engine idle times	**Date:** 5/3/11 ☒ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☐ Waste ☒ Criteria pollutants ☐ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

It is too early in the process for this BMP to be applied, but it should be considered during design and construction. Minimizing engine idle times will likely be done as a cost saving measure. The Project Team questioned whether this BMP could be effectively enforced, and it was agreed that the measures required for strict enforcement would not be worthwhile. Instead, this should be suggested and encouraged as a good practice.

BMP D-2: Ensure peak operating efficiency of equipment to reduce energy use and emissions Examples: - Perform preventative maintenance and operate equipment per manufacturer instructions - Perform retrofits involving low-maintenance multi-stage filters for cleaner engine exhaust - Use synthetic oil to extend operating life (and reduce waste oil) - Purchase newer equipment with reduced emissions	**Date:** 5/3/11 ☒ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☐ Waste ☒ Criteria pollutants ☐ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Same as BMP D-1.

BMP Category D: Energy/Emissions – Equipment Use

BMP D-3: Use alternate fuel options for equipment when possible

Examples:

- Compressed natural gas
- Biodiesel
- Ethanol blends
- Ultra-low sulfur diesel, wherever available (and as required by engines with PM traps)

Date: 5/3/11

☐ Applicable ☐ Evaluated ☐ Practical

Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

It is too early in the process for this BMP to be applied, but it should be considered during design and construction.

BMP D-4: Select appropriate equipment and/or power source for the job

Examples:

- Avoid using large excavators for small earthmoving projects
- Use direct push methods when possible to reduce drilling duration
- Compare potential use of electricity versus battery versus generator

Date: 5/3/11

☐ Applicable ☐ Evaluated ☐ Practical

Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

It is too early in the process for this BMP to be applied, but it should be considered during design and construction.

In general, a large excavator should be used due to the amount of material that will need to be excavated.

BMP Category D: Energy/Emissions – Equipment Use

BMP D-5: Use variable frequency drives on motors (e.g., pumps, blowers), or replace oversized motors with properly sized motors

Date: 5/3/11

☐ Applicable

☐ Evaluated

☐ Practical

Implemented?
(“N/A” if “Practical” not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

This BMP is not applicable for this project, since no pumps, blowers, or similar equipment will be used.

BMP D-6: Identify options for generating renewable energy for direct use in the remedy and/or for alternate use at or near the project site

Examples:

- Solar, wind, landfill gas (microturbines), combined heat and power, geothermal heat exchange
- Applications for remote areas such as solar pumps or solar flares (if demand is not continuous, the need for a battery backup may be avoided)
- Generate power or heat exchange from water to be discharged

Date: 5/3/11

☐ Applicable

☐ Evaluated

☐ Practical

Implemented?
(“N/A” if “Practical” not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Although this would not likely be implemented for remedy operation, solar panels have been considered as a future land use for the capped area by the airport through a third party lease agreement. Ballasted solar panels would be used so as to keep the soil cap intact. This is a more likely option than low profile wind turbines or biodiesel crops for this area, since the infrastructure required for wind energy would compromise the cap (cause penetrations that the Project Team indicated are not desirable), and crops would cause issues related to sediment and fertilizer runoff to the storm water drainage ditch.

BMP Category D: Energy/Emissions – Equipment Use

BMP D-7: Consider purchase of renewable energy certificates to offset emissions from the remedial activities	**Date:** 5/3/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Since this is a FUDS project, implementation of this and other BMPs is constrained by the need to conduct remedial activities at the lowest cost to do what is technically necessary.*	

BMP D-8: Design/modify housing required for above-ground treatment components for energy-efficiency Examples: - Passive lighting - Compact fluorescent lighting (CFL) or light-emitting diode (LD) lighting - Timers and/or motion control sensors for lighting - Shading - Minimize heating and cooling needs (building size, insulation, etc.)	**Date:** 5/3/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP is not applicable for this remedy, since there is no above-ground treatment component.*	

BMP Category D: Energy/Emissions – Equipment Use

BMP D-9: For remedies that involve groundwater or air extraction, optimize extraction to reduce flow rates (potentially beneficial with respect to energy use, materials usage, water resources, waste disposal, etc.)	**Date:** 5/3/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP is not applicable for this project.*	

BMP D-10: Consider pulsing for extraction of water or air to maximize mass removal per unit of time or energy, by extracting higher concentrations	**Date:** 5/3/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP is not applicable for this project.*	

BMP Category D: Energy/Emissions – Equipment Use

<table>
<tr><td colspan="3">BMP D-11: Run electrical equipment during times of lower electric demand if possible (this does not reduce energy use but could lower cost and also can lower stress on the energy grid during periods of peak demand)</td><td>Date: 5/3/11
☐ Applicable
☐ Evaluated
☐ Practical</td></tr>
<tr><td>Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social</td><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="2">Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

This BMP is not applicable for this project.</td></tr>
</table>

BMP Category E: Materials & Off-Site Services

BMP E-1: Use materials that are made from recycled materials
Examples:
- Steel
- Asphalt
- Plastics
- Concrete

Date: 5/3/11
☐ Applicable
☐ Evaluated
☐ Practical

Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

The Project Team does not plan to use many off-site materials. A silt fence may be installed.

BMP E-2: Optimize the amount of materials used
Examples:
- Experiment with different material amounts/doses
- Consider alternate materials
- Use timers or feedback loops and process controls for dosing
- MMRP projects: minimize quantities of donor explosives for MEC destruction

Date: 5/3/11
☒ Applicable
☒ Evaluated
☒ Practical

Implemented?
("N/A" if "Practical" not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☐ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☒ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

The Project Team does not plan to use many off-site materials. Since this BMP will correlate with cost, material use will be optimized. One aspect where the project team is minimizing potential materials usage is that the current design calls for grading of the borrow area rather than backfilling. This is a green approach because it does not require transport of clean fill material from offsite.

BMP Category E: Materials & Off-Site Services

<table>
<tr><td colspan="3">BMP E-3: Utilize less refined materials when feasible
Examples:
- Limestone instead of sodium hydroxide for pH adjustment
- Native fill instead of select fill</td><td>Date: 5/3/11
☒ Applicable
☒ Evaluated
☒ Practical</td></tr>
<tr><td>Implemented? ("N/A" if "Practical" not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☐ Economic ☐ Social</td><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="2">Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☒ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

Native soil will be used for the landfill cap rather than mining clay from another area.

Kevin Mieczkowski (USACE) suggested during the 2 March 2011 meeting that the mulch generated from vegetation clearing could potentially be used for roads on-site rather than gravel.</td></tr>
</table>

<table>
<tr><td colspan="3">BMP E-4: Identify opportunities for using by-products or "waste" materials from local sources in place of refined chemicals or materials
Examples:
- Cheese whey, molasses, compost, or off-spec food products for inducing anaerobic conditions
- Crushed concrete for use as fill
- Concrete from coal combustion byproducts</td><td>Date: 5/3/11
☒ Applicable
☒ Evaluated
☒ Practical</td></tr>
<tr><td>Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☒ Partially ☐ Not Yet ☐ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☐ Economic ☐ Social</td><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="2">Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☒ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

Significant mulch will be generated as a result of clearing during the remedy. Kevin Mieczkowski (USACE) suggested during the 2 March 2011 meeting that a portion of the mulch can be utilized by mixing a portion of woodchips in with smaller cut woodchips, seeded with "landfill mix", and fertilized to create appropriate grass on top of the cap.

Alternatively, the mulch could possibly be traded for topsoil from a local composting facility, or used for dust suppression and/or roads.

Topsoil in excavated areas and the landfill cover area will be stripped and stockpiled for future use in restoration of the site.</td></tr>
</table>

BMP Category E: Materials & Off-Site Services

<table>
<tr><td colspan="3">BMP E-5: Reduce demand on Publicly Owned Treatment Works (POTWs)
Examples:
- Discharge treated water to groundwater or to surface water rather than POTW
- Minimize amount of water requiring treatment</td><td>Date: 5/3/11
☐ Applicable
☐ Evaluated
☐ Practical</td></tr>
<tr><td>Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social</td><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="2">Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

This BMP is not applicable for this project, since purge water is disposed of off-site as investigation-derived waste.</td></tr>
</table>

BMP Category F: Water Resource Use

BMP F-1: Minimize water consumption

Examples:

- Sensors to turn off water when not needed
- Low flow fittings
- Minimize water needs for irrigation (landscape choices, use of mats and mulch)

Date: 5/3/11

☒ Applicable

☐ Evaluated

☐ Practical

Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☒ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Mulch may be used for dust suppression, which would reduce the amount of water needed. This could be evaluated further in the 60% Design.

BMP F-2: Preferentially use less refined water resources when feasible

Examples:

- Use extracted groundwater instead of potable water for chemical blending
- Capture and store rain/storm water for future use
- Employ rumble grates with a closed-loop gray-water washing system

Date: 5/3/11

☒ Applicable

☐ Evaluated

☐ Practical

Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☒ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Water may be needed for dust suppression, and perhaps for cap compaction. Water from the West Ditch can be used in place of more refined sources, though the Project Team will need to determine whether the West Ditch can provide the amount of water needed for dust suppression, waste compaction, watering grass, or other activities. One idea raised during the meeting is to excavate a portion of the West Ditch to create a pool of water that could be used for these items, and then serve as a wetlands. Another possibility is to capture some rainwater to augment other water for these purposes. This can be further evaluated in the 60% Design.

BMP Category F: Water Resource Use

BMP F-3: Use extracted and treated water for beneficial purposes Examples: - Irrigation - Potable water - Industrial process water	**Date:** 5/3/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

The only on-site water that could potentially be used is storm water. Water in proposed dug-out pond could be used for dust control, and be converted into potential wetlands after remediation.

BMP F-4: Promote groundwater recharge Examples: - Recharge extracted and treated water when beneficial uses of the water are not identified and reinjection is practical - Minimize site area covered by impervious surfaces to reduce runoff and maximize infiltration (unless such capping is a specific component of the remedial action)	**Date:** 5/3/11 ☒ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☒ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

This could be done using storm water from the site. Groundwater recharge and innovative storm water practices are of interest to the regulatory community in Ohio.

BMP Category F: Water Resource Use

<table>
<tr><td colspan="3">BMP F-5: Maintain water quality by preventing nutrient loading to surface water or groundwater
Examples:
- Use phosphate-free detergents instead of organic solvents or acids to decontaminate sampling equipment (if not required for some contaminants)</td><td>Date: 5/3/11
☒ Applicable
☐ Evaluated
☐ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☐ Economic ☐ Social</td><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="2">Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☒ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

This BMP should be considered and applied to the extent practicable when fertilizing the new landfill seed mixture.</td></tr>
</table>

BMP Category G: Waste Generation, Disposal, and Recycling

BMP G-1: Minimize drill cuttings and all other investigation derived waste (including personal protection equipment)

Examples:

- Direct push or sonic drilling to reduce drill cuttings
- Low-flow sampling or passive diffusion bags (if applicable) to reduce purge water
- When possible place drill cuttings on-site rather than off-site disposal

Date: 5/3/11

☒ Applicable

☐ Evaluated

☐ Practical

Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☐ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☒ Hazardous air pollutants ☒ Energy ☒ Waste
☒ Criteria pollutants ☐ Materials ☒ Safety/Community
☒ GHG emissions (CO2e) ☒ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

The only significant investigation derived waste is the purge water from sampling. As discussed above, the use of whole-water or no-purge samplers such as HydraSleeve™ (if acceptable) rather than low flow sampling would reduce or eliminate this waste.

The Project Team also plans to time the new well installation so that cuttings can be placed in the on-site consolidation area.

BMP G-2: Segregate excavated soil in pre-planned staging areas so that "clean" material can be deposited on-site and/or re-used rather than transported for off-site disposal

Date: 5/3/11

☐ Applicable

☐ Evaluated

☐ Practical

Implemented? ("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

There will be little off-site disposal, and segregating could complicate the schedule for this project.

BMP Category G: Waste Generation, Disposal, and Recycling

BMP G-3: Consider on-site treatment and re-use of soil instead of off-site disposal Examples: - Land farming - Above ground soil vapor extraction (SVE)	**Date:** 5/3/11 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☐ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Excavated waste will be consolidated and capped on-site. Off-site disposal is not being considered.*	

BMP G-4: Minimize need to transport and dispose hazardous waste Examples: - Consider delisting listed hazardous waste if waste is not characteristically hazardous waste - Segregate hazardous waste and non-hazardous waste	**Date:** 5/3/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP is not applicable for this project, as there is no hazardous waste. The only potential source of hazardous waste might be drums (if any) buried in the landfill. If these drums (if any) contain product, then they will be disposed of as hazardous waste. However, if empty drums are found and sampling shows that significant levels of contamination are not present, the drums will be kept on-site.*	

BMP Category G: Waste Generation, Disposal, and Recycling

BMP G-5: When possible avoid/minimize use of hazardous/toxic materials that may require special handling or disposal

Examples:

- Cleaning solutions
- Pesticides
- Disposable batteries (use rechargeable batteries)
- MMRP projects: minimize Chemical Agent Contaminated Media (CACM) at RCWM sites.

Date: 5/3/11

☐ Applicable

☐ Evaluated

☐ Practical

Implemented?
(“N/A” if “Practical” not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

This BMP is not applicable for this project.

BMP G-6: Recycle or re-use materials rather than disposing of them

Examples:

- Cardboard
- Plastics
- Concrete
- Asphalt
- Steel and other metals
- Recovered oil/product
- Mulch/compost
- MMRP projects - recycle recovered Material Documented as Safe (MDAS) after inspection and certification that the remnants are free of explosive hazards

Date: 5/3/11

☒ Applicable

☒ Evaluated

☒ Practical

Implemented?
(“N/A” if “Practical” not checked)
☐ Fully ☐ Partially ☒ Not Yet ☐ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☒ Economic ☒ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☒ Hazardous air pollutants ☒ Energy ☒ Waste
☒ Criteria pollutants ☒ Materials ☒ Safety/Community
☒ GHG emissions (CO2e) ☐ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

The mulch from vegetation clearing will be used wherever possible (see BMB E-4 for details). During the meeting on 2 March 2011, the disposition of large slabs of asphalt or concrete that might be excavated was discussed. The GSR Team asked if it would be beneficial to segregate such items for potential re-use elsewhere. The Project Team indicated that they felt the segregation process would require so much more labor, sampling, and use of machinery that it would not represent a net benefit. They also suggested that approach could delay the schedule, and also stated they might need the material in the capped area to achieve the desired grade.

BMP Category H: Land Use, Ecosystems, and Cultural Resources

BMP H-1: Minimize erosion and soil transport to surface water bodies

Examples:

- Quickly restore any vegetated areas disrupted by equipment or vehicles
- Institute appropriate erosion controls during excavation such as silt fencing

Date: 5/3/11

☒ Applicable

☒ Evaluated

☒ Practical

Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☒ Partially ☐ Not Yet ☐ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☐ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☒ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Soil/erosion controls will be put in place when removing the concrete structure from the stream.

Sediment controls will be established in the borrow pit area to protect the west ditch.

After capping, vegetation (i.e. a local landfill vegetation mix) will be planted on top of the landfill to control erosion.

These would be done regardless, and cost impacts are not quantified.

BMP H-2: Minimize disturbances to land

Examples:

- Establish well-defined traffic patterns for onsite activities to minimize disturbed areas
- Consider non-intrusive investigation techniques (e.g., geophysical methods) to identify items like USTs and buried drums

Date: 5/3/11

☒ Applicable

☒ Evaluated

☒ Practical

Implemented?
("N/A" if "Practical" not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☐ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☒ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Excavation will only take place in those areas where there is waste, and borrow will be taken from AOC 1 so as not to disturb AOC 2.

BMP Category H: Land Use, Ecosystems, and Cultural Resources

BMP H-3: Preserve/restore ecosystems to the extent possible
Examples:
- Limit the removal of trees and vegetation
- Attempt to transplant disturbed shrubs and small trees to other locations
- Use native species for re-vegetation
- Retrieve dead trees during excavation and later reposition them as habitat snags
- Select and place suitably sized and typed stones into water beds and banks
- Undercut surface water banks in ways that mirror natural conditions
- Cut back rather than remove trees, bushes, vegetation

Date: 5/3/11

☒ Applicable
☒ Evaluated
☐ Practical

Implemented? ("N/A" if "Practical" not checked): ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☒ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

The remedy will inevitably disturb some vegetation, and in the capped area, trees and other large vegetation cannot be restored because of the need to maintain the landfill cap.

Kevin Mieczkowski (USACE) suggested during the meeting on 2 March 2011 that it might be a good idea during construction to dig out an area in the West Ditch in the vicinity of the borrow area to allow pooling of water that could be accessed for water needs such as dust control. That area could subsequently serve as flood control and/or a wetlands area.

The configuration of the cap and excavation areas in the current design also eliminates any need to disturb AOC 2, thus minimizing disturbance to a heavily forested area until that area is placed into other use by the landowner.

The Project Team indicated they will have further discussion on the use of native species for revegetation; use of dead trees for habitat snags; placement of suitably sized stones in water beds and banks; undercutting of water banks.

BMP H-4: Minimize drawdown of the water table in sensitive areas such as wetlands or areas subject to subsidence

Date: 5/3/11

☐ Applicable
☐ Evaluated
☐ Practical

Implemented? ("N/A" if "Practical" not checked): ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

This BMP is not applicable for this project, since no significant extraction will likely take place.

BMP Category H: Land Use, Ecosystems, and Cultural Resources

BMP H-5: Construct wells and other remedial process infrastructure (piping, buildings, etc.) to minimize restrictions to anticipated future use of the site	**Date:** 5/3/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < \$10,000 ☐ \$10,001 - \$50,000 ☐ \$50,001 - \$100,000 ☐ \$100,001 - \$500,000 ☐ > \$500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

This BMP is generally not applicable for this project. The only infrastructure will be passive vents, and these will need to be spaced at a certain interval in a grid pattern. Since very little methane gas production is anticipated, there will likely be few vents.

BMP H-6: Preserve/restore cultural resources to the extent possible Examples: - Protected lands such as wildlife refuges, national parks, and wilderness areas - Culturally sensitive sites such as cemeteries, native burials, and archaeological finds - Buildings or land parcels with historical significance	**Date:** 5/3/11 ☒ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < \$10,000 ☐ \$10,001 - \$50,000 ☐ \$50,001 - \$100,000 ☐ \$100,001 - \$500,000 ☐ > \$500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

This BMP is not applicable for this project.

BMP H-7: Document sensitive ecological and cultural resources prior to initiating actions that might diminish or destroy those resources Examples: - Photodocument conditions prior to clearing brush - MMRP projects: photodocument conditions prior to BIP	**Date:** 5/3/11 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

The Indiana Bat may use areas of the site during certain times of the year, and clearing will be planned between the months of September and March if the bat is found to be an issue.

A wetland delineation survey for the site is currently under consideration to be performed in March 2011. A wetlands disturbance permit may need to be obtained for the wetlands on the site if they overlap with areas proposed for construction. These wetlands may or may not need to be restored.

BMP Category I: Safety and Community

<table>
<tr><td colspan="3">BMP I-1: Minimize and mitigate noise, light and odor disturbance during all phases of the remedial process, to the extent practicable</td><td>Date: 5/3/11
☐ Applicable
☐ Evaluated
☐ Practical</td></tr>
<tr><td>Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social</td><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="2">Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

There are no major concerns over these types of disturbances for this project.</td></tr>
</table>

<table>
<tr><td colspan="3">BMP I-2: Minimize dust during construction activities by spraying water or techniques such as laying biodegradable mats, tarps, or materials (already in EM385-1-1)</td><td>Date: 5/3/11
☒ Applicable
☐ Evaluated
☐ Practical</td></tr>
<tr><td>Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☒ Social</td><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="2">Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☒ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☒ BMP otherwise required?
If checked, required by:
EM385-1-1</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

Water or mulch will be used to control dust, but the specific approach has not been fully evaluated. Obtaining water from the ditch on-site or from surface water collected in an excavated pond area or using mulch from chipping of trees removed from the site during remediation is considered GSR.</td></tr>
</table>

BMP Category I: Safety and Community

BMP I-3: Select transportation routes for trucks and heavy equipment that minimize impacts to residential areas to maximize safety and minimize noise and other aesthetic impacts	**Date:** 5/3/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This could potentially be a concern for the Lockbourne community, particularly with mulch removal if all mulch cannot be used onsite, but most of the major activity will take place on-site.*	

BMP I-4: Minimize drawdown of the water table in areas that could impact production rates at supply wells and/or irrigation wells	**Date:** 5/3/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP is not applicable for this project.*	

BMP Category I: Safety and Community

BMP I-5: Minimize amount of time that heavy machinery is needed to enhance safety	**Date:** 5/3/11 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☒ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☒ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP will likely be implemented because it correlates with cost.*	

BMP I-6: Minimize handling of dangerous chemicals by selecting alternate chemicals and/or engineering to minimize contact with chemicals (for MMRP projects, there is enhanced risk related to explosion potential and exposure to chemical agents (CA) and agent breakdown products (ABP) associated with RCWM responses)	**Date:** 5/3/11 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☒ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *The excavation will be in the "lightly use" area rather than the "heavily used" area with regard to previous waste disposal, which will reduce exposure to chemicals. In addition, not segregating excavated material will minimize potential for contact with dangerous chemicals.*	

<table>
<tr><td colspan="3">BMP I-7: Contribute to local economy when possible
Examples:
- Consider leasing local office space
- Purchase or lease equipment from local vendors
- Hire workers from local community</td><td>Date: 5/3/11
☒ Applicable
☒ Evaluated
☒ Practical</td></tr>
<tr><td>Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☒ Not Yet ☐ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☒ Social</td><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="2">Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☒ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

Space could be leased from the airport during remedy implementation.</td></tr>
</table>

BMP Category J: Other Site-Specific BMPs

BMP J-1:	**Date:** ☐ Applicable ☐ Evaluated ☐ Practical

Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP):	

BMP J-2:	**Date:** ☐ Applicable ☐ Evaluated ☐ Practical

Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP):	

APPENDIX B

Assumptions for SiteWise Input and Other Calculations, Lockbourne Landfill Pilot GSR Evaluation:

Alternative 1 – Current Design

Appendix B
Assumptions for SiteWise Input and Other Calculations
Lockbourne Landfill Pilot GSR Evaluation
Consolidation and Capping (Baseline)

Baseline Remedy – Landfill Consolidation and Soil Cap – SiteWise "Alternative 1" Directory

- Clearing and grubbing of existing vegetation (no grubbing in capped area)
- Stripping and stockpiling of existing topsoil
- Excavating waste in the non-capped area and consolidating waste within the area to be covered
- Rough grading of the landfill surface in preparation for constructing the soil cover using consolidated waste materials
- Constructing a soil cover consisting of a 24 inch compacted soil layer, overlain with 6 inches of cover material suitable for establishing and supporting the vegetation selected for the cover
- Restoring waste excavation and onsite borrow source areas
- Implementing a passive gas venting system
- Implementing long-term operations and maintenance (O&M) measures to ensure the protectiveness of the cover
- Installing a drainage swale
- Defining a monitoring well network
- Implementing the environmental covenants to restrict use to industrial/commercial activities, prohibit intrusive activities on the landfill cover, and restrict the use of site groundwater

The notes pertaining to SiteWise input are organized by the following sections of SiteWise input:

- Site Preparation – Uses "Remedial Action Investigation" tab of SiteWise input for SiteWise "Alternative 1"

- Excavation, Consolidation, and Capping – Uses "Remedial Action Construction" tab of SiteWise input for SiteWise "Alternative 1"

- Site Restoration, Grading, and Installation of Remedy Infrastructure (passive gas vents, monitoring wells) – Uses "Remedial Action Operations" tab of SiteWise input for SiteWise "Alternative 1"

- LTM – Uses "Longterm Monitoring" tab of SiteWise input for "SiteWise "Alternative 1"

For each section of SiteWise, all the sections are listed, with pertinent information added only for those sections of the input sheet where data were added.

Baseline – Overview

Other calculations done outside of SiteWise are then presented. These include the following:

- % of total energy from renewable resources
- Hazardous air pollutants
- Refined material use
- Unrefined material use
- Tons of non-hazardous waste
- Tons of hazardous waste
- Risks to on-site works and from transportation
- Heavy truck trips through residential areas

Additional tables are attached which show how SiteWise outputs were split into “direct” and “indirect” energy use and greenhouse gas emissions. For definitions of direct and indirect energy use and emissions, please refer to section 2.2.2 of the evaluation report.

A cost sheet is also attached. Cost estimates are based on the detailed cost analysis provided in Appendix A of the Draft Final FFS (specifically, pages 2, 3, and 5), augmented/modified based on information subsequently provided in the 30% Design. Information regarding the cost calculations is as follows:

- Individual cost sheets detailing the estimated capital and annual costs are provided in separate spreadsheets as follows:
    - ICs
    - LTM
    - Consolidation and Soil Cap

- These results are then summarized in a combined spreadsheet to calculate life-cycle costs (with and without discounting) based on the combined up-front and annual costs.

    - The capital cost for the remedy is approximately $5.49 million.

    - Not counting costs every five years for “renewal and replacement”, the annual O&M cost for years 1-2 is approximately $239,000, the annual O&M cost for years 3-5 is approximately $136,000, and the annual O&M cost for years 6-30 is approximately $85,000. Periodic costs every 5th year are on the order of $16,000 for the cap and on the order of $65,000 for LTM.

    - Capital costs are assumed to occur in year 0, and annual costs are assumed to occur in years 1 to 30.

    - To determine net present value (NPV), a 2.7 percent discount rate is applied to future costs, which is consistent with the discount rate applied in the Draft Final FFS.

    - NPV is calculated by discounting future costs to present-day dollars using the following equation:

$$PV = \frac{FV}{(1+i)^n} = C \times FV$$

Baseline – Overview

PV is the present value
FV is the value in year “n” (i.e., future value)
i is the discount rate
C is the discount factor, which equals $1/(1+i)^n$

Baseline – Site Preparation

Scope of Work

- Stripping and stockpiling of at least 20,500 cy of topsoil (this amount needed for landfill cover)
  - Assume 4 people, two 200HP dozers, ~1730 cy/day (RSMeans)
- Clearing vegetation over ~55.7 acres
  - Area 1 = 8.6 acres (minus ~8 acres overlapping with borrow area = 0.6 acres)
  - Area 2= 6.7 acres (minus ~3 acres overlapping with borrow area = 3.7 acres)
  - Area 3 = 2.6 acres
  - Area 4 = 0.5 acres
  - Area 5 = 1.6 acres
  - Borrow area = 22 acres
  - Area to be capped = 24.7 acres
  - Total = 55.7 acres
  - Assume 10 people, two 130HP brush chippers, 2 crawler loaders, 4 gas-powered chainsaws (negligible footprint from chainsaws, not included in SiteWise inputs), ~2 acres/day (estimated from RSMeans)
- Grubbing vegetation over ~31 acres
  - Total from above minus capped area (55.7-24.7=31)
  - Assume 3 people, 1 excavator, 2 dump trucks, ~2 acre/day (RSMeans)
- Erosion and sedimentation control installation
  - Temporary mulching or erosion blankets, hay bales and silt fences, and stone/hay bale check dams will be used during construction as E&S controls.
  - Assume 2 people, 22 days

    Negligible footprint from E&S controls materials and equipment use for installation, not included in SiteWise inputs
- Design figures appear to indicate abandonment of 4 monitoring wells (only 2 in some figures, but all 4 wells are within the footprint of the landfill cap, so it is assumed that all will be abandoned). Well depths are as follows:
  - LCKMW-5: 79.85 ft
  - LCKMW-6: 22.63 ft
  - LCKMW-12A: 74.91 ft
  - LCKMW-13: 26.57 ft

  Assume 2 people, 2 days

- From 30% Design Construction Schedule:
  - 5 days for mobilization to the project site
  - 24 days for clearing and vegetation removal
  - 22 days for E&S control installation
  - 10 days for monitoring well abandonment
  - 35 days from start to finish (some overlap between tasks)

Baseline – Site Preparation

<u>SiteWise Input – Input into "Remedial Action Investigation" tab of SiteWise "Alternative 1"</u>

- Material Production
  - Well Materials
  - Treatment Chemicals & Materials
  - GAC
  - Construction Materials
  - Well Decommissioning – all wells assumed to be 4-inch diameter, material assumed to be cement
    - Type 1 – LCKMW-5: 79.85 ft
    - Type 2 – LCKMW-6: 22.63 ft
    - Type 3 – LCKMW-12 A: 74.91 ft
    - Type 4 – LCKMW-13: 26.57 ft

- Transportation
  - Personnel Transportation – Road
    - Trip 1 – assume for this phase of work that there will be 8 round-trips in a light truck per day for 35 days = 280 trips.
  - Personnel Transportation – Air
  - Personnel Transportation – Rail
  - Equipment Transportation – Road
    - Trip 1 – dozers for topsoil stripping/stockpiling: assume two 40 mile round trips per dozer (40*2 dozers * 2 round trips=160 miles) at 40 tons each (i.e., assign half weight = 20 tons to account for each return trip). Select diesel for fuel type.
    - Trip 2 – brush chippers for clearing: assume two 40 mile round trips for each brush chipper (40*2 chippers*2 round trips=160 miles) at 1 ton each (i.e., assign half weight = 0.5 tons to account for each return trip). Select gasoline for fuel type.
    - Trip 3 – crawler loaders for clearing: assume two 40 mile round trips per crawler loader (40*2 crawlers*2 round trips=160 miles) at 15 tons each (i.e., assign half weight = 7.5 tons to account for each return trip). Select diesel for fuel type.
    - Trip 4 – excavator for grubbing: assume two 40 mile round trips (40*1 excavator*2 round trips=80 miles), at 15 tons (i.e., assign half weight = 7.5 tons to account for each return trip). Select diesel for fuel type.
    - Trip 5 – dump trucks for grubbing: assume it is driven to site, one 40 mile round trip per dump truck (40*2=80) at 15 tons each. Select diesel for fuel type.
  - Equipment Transportation – Air
  - Equipment Transportation – Rail
  - Equipment Transportation – Water

- Equipment Use
  - Earthwork
    - Equipment 1 – dozer: 2 dozers for stripping/stockpiling 20,500 cy of topsoil. RSMeans indicates production rate of 1,730 cy/day = ~12days of dozer operation. Adjust number of cubic yards in input file so that hours of equipment operation in SiteWise output file matches the 12 days = 96 hrs calculated above. This method leads to 97,425 cy of material to be removed assigned in SiteWise.

        - Equipment 2 – loader: 2 crawler loaders for clearing vegetation. Adjust number of cubic yards in input file so that hours of equipment operation in SiteWise output file matches the 24 days allotted in construction schedule, assuming 8 hr days. In order account for 2 loaders working simultaneously, divide number of operating hours by two (383.2 hrs/2/8=23.95 days). This method leads to 252,000 cy of material to be removed.
        - Equipment 3 – excavator: 1 excavator for grubbing vegetation. Adjust number of cubic yards in input file so that hours of equipment operation in SiteWise output file matches the 16 days calculated above using daily output rates from RSMeans, assuming 8 hr days (128.9 hrs/8=16.1125 days). This method leads to 29,000 cy of material to be removed.
        - Equipment 4 – use scraper: used to represent 2 dump trucks for grubbing vegetation. Adjust number of cubic yards in input file so that hours of equipment operation in SiteWise output file matches the 16 days calculated above using daily output rates from RSMeans, assuming 8 hr days. In order account for 2 loaders working simultaneously, divide number of operating hours by two (255.8/2/8=15.9875). This method leads to 146,500 cy of material to be removed.
    - Drilling
    - Pump operation
    - Diesel and Gasoline Pumps
    - Blower, Compressor, Mixer, and Other Equipment
    - Generators
        - Generator 1 – used to represent two 130 HP brush chippers operated for 8 hours per day for 24 days (2*8*24=384 hours)
    - Agricultural Equipment
    - Capping Equipment
    - Mixing Equipment

- Residual Handling
    - Residue Disposal/Recycling
    - Landfill Operations
    - Thermal/Catalytic Oxidizers
    - Water Consumption
    - Landfill Methane Emissions

- Other Known On-Site Activities
    - CO_2 Emissions

Baseline – Excavation, Consolidation, and Capping

<u>Scope of Work</u>

- Excavation/consolidation of waste
    - ~140,000 cy of waste excavation from Areas 1-5 (from 30% design text).
        - Note: 30% design figures indicate 153,200 cy of fill required for capped area. In addition, figures for individual excavation areas list cy of waste removal, and these numbers only add up to 133,061 cy. 140,000 cy will be used for calculating SiteWise input.
    - Assume 4 people, 2 excavators.
- Borrow excavation
    - 22 acres and 111,500 cy of cover soil material from onsite borrow source (from 30% design drawings).
    - Assume 4 people, 2 excavators.
- Installation of cap over 24.7 acres
    - 24 inch compacted soil cover layer with a minimum hydraulic conductivity of 1×10^{-6} cm/sec. Total soil needed = 88,000 cy from onsite borrow source (from 30% design drawings)
        - Note: 30% design text says 80,000 cy. 88,000 cy will be used for calculating SiteWise input.
    - Compacted cover soil will be placed and compacted into four 6-inch lifts
    - Assume 2 people, 2 dozers, and 1 roller.
- Topsoil layer over capped area
    - 6 inch topsoil layer. Total soil needed = 20,500 cy of material stripped from the site during waste excavation (if possible and agreeable to stakeholders)
    - Topsoil will be placed with low ground-pressure equipment and will be compacted lightly.
    - Assume 2 people, 2 dozers
- Planting appropriate vegetation over landfill cap. Uppermost 2 inches of topsoil will be treated with seeding mixes, lime and/or fertilizer as necessary. Assume negligible equipment use compared to other items.
- During construction, E&S controls will be inspected once per week (and within 24 hours of storm events).

- From 30% Design Construction Schedule:
    - 40 days for waste consolidation
    - 35 days for 24-inch cover soil placement
    - 20 days for 6-inch top soil placement
    - 75 days from start to finish (some overlap between tasks)

Baseline – Excavation, Consolidation, and Capping

<u>SiteWise Input – Input into "Remedial Action Construction" tab in SiteWise "Alternative 1"</u>

- Material Production
  - Well Materials
  - Treatment Chemicals & Materials
  - GAC
  - Construction Materials
  - Well Decommissioning

- Transportation
  - Personnel Transportation – Road
    - Trip 1 – assume for this phase of work that there will be 4 round-trips in a light truck per day for 75 days = 300 trips.
  - Personnel Transportation – Air
  - Personnel Transportation – Rail
  - Equipment Transportation – Road
    - Trip 1 – 4 excavators to be delivered for this phase. Assume two 40 mile round trips (40*4 excavator*2 round trips=320 miles), at 15 tons (i.e., assign half weight = 7.5 tons to account for each return trip). Select diesel for fuel type.
    - Trip 2 – 2 dozers to be delivered for this phase. Assume two 40 mile round trips per dozer (40*2 dozers*2 round trips=160 miles) at 40 tons each (i.e., assign half weight = 20 tons to account for each return trip). Select diesel for fuel type.
    - Trip 3 – 1 roller to be delivered for this phase. Assume two 40 mile round trips (40*1 roller*2 round trips=80 miles), at 12 tons (i.e., assign half weight = 6 tons to account for each return trip). Select diesel for fuel type.
  - Equipment Transportation – Air
  - Equipment Transportation – Rail
  - Equipment Transportation – Water

- Equipment Use
  - Earthwork
    - Equipment 1 – Assume 2 excavators operating at the same time, each moving 70,000 cy of waste. According to SiteWise output file, each will operate for 311 hours (622 hours/2), or 38.875 8-hrdays (311/8), which is similar to the estimated 40 days for waste consolidation in the construction schedule. Assume diesel fuel.
    - Equipment 2 - Assume 2 excavators operating at the same time, each moving 55,750 cy of soil. According to SiteWise output file, each will operate for 247.7 hours (495.4 hours/2), or 30.9625 8-hr days (247.7/8), which fits within the estimated 35 days for cover soil placement in the construction schedule. Assume diesel fuel.
    - Equipment 3 – Dozer. Assume for soil cover plus topsoil requires on order of 50 days for 2 dozers = 100 days of production = 800 hrs. Adjust input cy for dozers so SiteWise output reflects 800 hrs of use. This equates to 812,734 cy to be input to SiteWise.
  - Drilling
  - Pump operation
  - Diesel and Gasoline Pumps

- Blower, Compressor, Mixer, and Other Equipment
- Generators
- Agricultural Equipment
- Capping Equipment
  - Equipment 1 – Roller. SiteWise needs input in area. Use 24.7 acres*43,560 ft^2 per acre = 1,075,932 ft^2. Use 35 days from Construction Schedule for soil cover placement.
- Mixing Equipment

- Residual Handling
  - Residue Disposal/Recycling
  - Landfill Operations
  - Thermal/Catalytic Oxidizers
  - Water Consumption
  - Landfill Methane Emissions

- Other Known On-Site Activities

Baseline – Site Restoration, Grading, and Installation of Remedy Infrastructure

Scope of Work

- Restoration of excavated waste areas and borrow area
    - Waste Excavations 3 and 4 will be restored with borrow soils to the existing grades
        - Area 3 = 21,161 cy and Area 4 = 2,700 cy
    - Select parts of Waste Excavations 1,2, and 5 will be backfilled as needed, but mostly will be left at the final excavated grades
    - Borrow areas are to be graded in accordance with drawings (mostly excavated to final grade)
    - Borrow areas will be seeded in the same fashion as the landfill cover, but no topsoil will be placed in this area
- Disturbed wetland areas will be backfilled to their existing grades. Top soil and planting will occur as required by the wetland disturbance permits.
- Grading to 4% slope over 24.7 acres
- Installing passive gas vents
    - Passive gas vents will be spaced on an ~200 ft grid
        - Note: design figures indicate 27 vents total, but at the design meeting on 2 March 2011 it was indicated that there would actually be fewer than this. Cost sheets from FFS indicate 25 vents.
    - 4-inch, PVC schedule 40 riser pipes
    - Need to penetrate through final cover liner system, so below ground portion will need to be at least 30 inches.
    - Given statement there will be just a few of these, and that there is so much other equipment already mobilized, it is assumed that the materials and activity required for the passive gas vents will be negligible with respect to the overall construction effort.
- Installing monitoring wells
    - Cost sheets in Draft Final FFS indicate installation of 5 new wells and replacement of abandoned wells. 30% design figures appear to indicate abandonment of 4 wells, so assume 9 wells installed for calculating SiteWise inputs.

- From 30% Design Construction Schedule:
    - 10 days for gas vent and gas probe installation
    - 15 days for monitoring well installation
    - 20 days for surface water/site restoration and grading
    - 5 days for demobilization from the site
    - 10 days for as-built survey
    - 35 days from start to finish (some overlap between tasks)

Baseline – Site Restoration, Grading, and Installation of Remedy Infrastructure

<u>SiteWise Input – Input into "Remedial Action Operations" tab in SiteWise "Alternative 1"</u>

- Material Production
    - Well Materials
        - Well Type 1 – 9 wells, assume 4-inch PVC, assume average depth of 80 ft
    - Treatment Chemicals & Materials
    - GAC
    - Construction Materials
    - Well Decommissioning
        - Well Type 1 – chosen to represent cement grout use for well installation

- Transportation
    - Personnel Transportation – Road
        - Trip 1 – assume for this phase of work that there will be 4 round-trips in a light truck per day for 35 days = 140 trips.
        - Trip 2 – Round-trip for light truck supporting drill rig (daily trips) for 9 days (one day per well), 40 miles round trip
        - Trip 3 – Round-trip for drill rig (heavy duty, weekly trips for 2 weeks), 40 miles round trip
        - Trip 4 – Round-trip for heavy duty truck supporting drill rig (weekly trips for 2 weeks), 40 miles round trip
    - Personnel Transportation – Air
    - Personnel Transportation – Rail
    - Equipment Transportation – Road
        - Assume all equipment needed for this task is already at the site from the previous tasks, so no specific equipment delivery is associated with this task (transport below is for well materials).
        - Trip 1 – mileage and tonnage for transporting PVC for wells. Assume 40 miles round trip. Calculate tonnage by taking weight of PVC in pounds from Material Production tab of Remedial Investigation sheet, dividing by 2000 pounds per ton, and dividing by 2 to provide an average of the tonnage for the delivery trip and empty return trip (1447 lbs/2000/2=approximately 0.4 ton).
        - Trip 2 – mileage and tonnage for transporting cement grout for wells. Assume 40 miles round trip. Calculate tonnage by taking weight of cement in kgs from Material Production tab of Remedial Investigation sheet, multiplying by 2.2 to convert to pounds, dividing by 2000 pounds per ton, and dividing by 2 to provide an average of the tonnage for the delivery trip and empty return trip (2,678 kg*2.2/2000/2= 1.5 tons).
    - Equipment Transportation – Air
    - Equipment Transportation – Rail
    - Equipment Transportation – Water

- Equipment Use
    - Earthwork
        - Assume 2 dozers for 20 days = 40 days of production = 320 hrs. Adjust input cy for dozers so SiteWise output reflects 320 hrs of use. This equates to 325,000 cy to be input to SiteWise.

  - Drilling
    - Event 1 – assume hollow stem auger, 9 wells, avg 80 ft depth, 8 hrs per well
  - Pump operation
  - Diesel and Gasoline Pumps
  - Blower, Compressor, Mixer, and Other Equipment
  - Generators
    - Generator 1 – operate well development pumps; assume 4 hours per well = 36 hours
  - Agricultural Equipment
  - Capping Equipment
  - Mixing Equipment

- Residual Handling
  - Residue Disposal/Recycling
  - Landfill Operations
  - Thermal/Catalytic Oxidizers
  - Water Consumption
    - Development water assumed to be discharged to ground or negligible in overall project
  - Landfill Methane Emissions

- Other Known On-Site Activities

Baseline – LTM

Scope of Work

- Periodic inspection and maintenance of the landfill cover during 30-year post-closure period
    - Cost analysis from Draft Final FFS indicates biannual cover inspections and mowing,
- Groundwater monitoring
    - Quarterly for years 1 & 2, semi-annually years 3 through 5 (re-evaluated during 5-year review, but costs assume lower cost after year 5)
    - Low-flow sampling
- All other items (such as cooler shipping, purge water handling) assume to be negligible.

Baseline – LTM

<u>SiteWise Input – Input into “Longterm Monitoring” tab in SiteWise “Alternative 1”</u>

- Material Production
    - Well Materials
    - Treatment Chemicals & Materials
    - GAC
    - Construction Materials
    - Well Decommissioning

- Transportation
    - Personnel Transportation – Road
        - Trip 1 – cap maintenance: 15 visits over 30 years, assume 40 mile round trip, light truck
        - Trip 2 – groundwater monitoring: low flow sampling, assume following number of trips
            - Years 1-2: 30 trips per year * 2 years = 60
            - Years 3-5: 15 trips per year * 2 years = 30
            - Years 6-30: 4 trips per year * 25 years = 100
            - Total trips = 190
            - Assume 40 miles round trip, light truck
    - Personnel Transportation – Air
    - Personnel Transportation – Rail
    - Equipment Transportation – Road
    - Equipment Transportation – Air
    - Equipment Transportation – Rail
    - Equipment Transportation – Water

- Equipment Use
    - Earthwork
    - Drilling
    - Pump operation
    - Diesel and Gasoline Pumps
    - Blower, Compressor, Mixer, and Other Equipment
    - Generators
    - Agricultural Equipment
    - Capping Equipment
    - Mixing Equipment

- Residual Handling
    - Residue Disposal/Recycling
    - Landfill Operations
    - Thermal/Catalytic Oxidizers
    - Water Consumption – Purge water from sampling is negligible
    - Landfill Methane Emissions

- Other Known On-Site Activities

Other Supporting Calculations
Lockbourne Landfill Pilot GSR Evaluation
Alternative 1 – No Action (Baseline P&T Option)

% of Total Energy Usage from Renewable Resources

- None identified

Hazardous Air Pollutants

- None identified

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Refined Materials Use

- Includes the following refined materials as the primary refined materials involved in the project:
  - PVC for monitoring wells – SiteWise indicated 1,447 lbs for monitoring well installation
  - Cement grout used for monitoring wells and well decommissioning – SiteWise indicated 2,678 kg for monitoring well installation + 297 kg for decommissioning =2,975 kg *2.2=6545 lbs

- Other refined materials assumed to have negligible contribution to total materials use

Unrefined Materials Use

- None identified (not counting materials derived from on-site)

Tons of Non-Hazardous Waste

- Assuming all mulch used on-site, none identified

Tons of Hazardous Waste

- None identified

Risks to On-Site Workers and from Transportation

- Refer to “Total” tab of the “Summary.xlsx” spreadsheet
- For transportation related risks, sum injuries and fatalities for all transportation activities
- Add total risk form transportation and non-transportation, and then subtract the transportation sums previously calculated, to get non-transportation

Heavy Truck Trips through Residential Areas

- This is for equipment delivery, drill rig transport, etc.

Baseline – Other Supporting Calculations

- Based on equipment transport in notes above, this is 76 one-way trips for heavy trucks/equipment

GSR Team Calculations to Split Energy Results from SiteWise into "Direct" and "Indirect"

	Reported by SiteWise		Assigned by GSR Team from SiteWise Output			Added by GSR Team	
			Scope 1 (direct)	Scope 2 (indirect)	Scope 3 (indirect)	Scope 3 (indirect)	
phase	activity	energy used (MMBTU)	energy used (MMBTU)	energy used (MMBTU)	energy used (MMBTU)	energy used (MMBTU)	Total Calculated by GSR Team
site preparation (remedial investigation tab)	Consumables	3.31			3.31		3.31
	Transportation-Personnel	92.59			92.59	22.22	114.81
	Transportation-Equipment	12.72			12.72	3.05	15.78
	Equipment Use and Misc	1943.83	1943.83			466.52	2410.35
	Residual Handling	0.00					0.00
	Sub-Total	2052.45	1943.83	0.00	108.62	491.79	2544.24
excavation, consolidation, and capping (remedial action construction tab)	Consumables	0.00					0.00
	Transportation-Personnel	99.20			99.20	23.81	123.01
	Transportation-Equipment	11.54			11.54	2.77	14.31
	Equipment Use and Misc	7109.14	7109.14			1706.19	8815.34
	Residual Handling	0.00					0.00
	Sub-Total	7219.88	7109.14	0.00	110.74	1732.77	8952.65
site restoration, grading, and installation of remedy infrastructure (remedial action operations tab)	Consumables	53.67			53.67		53.67
	Transportation-Personnel	52.05			52.05	12.49	64.54
	Transportation-Equipment	1.40			1.40	0.34	1.74
	Equipment Use and Misc	1493.62	1493.62			358.47	1852.09
	Residual Handling	0.00					0.00
	Sub-Total	1600.75	1493.62	0.00	107.13	371.30	1972.04
LTM (longterm monitoring tab)	Consumables	0.00					0.00
	Transportation-Personnel	67.79			67.79	16.27	84.06
	Transportation-Equipment	0.00					0.00
	Equipment Use and Misc	0.00					0.00
	Residual Handling	0.00					0.00
	Sub-Total	67.79	0.00	0.00	67.79	16.27	84.06
total		10940.86	10546.59	0.00	394.27	2612.13	13553.00

Note: *For energy use related to fuel use for transportation or on-site equipment use, SiteWise reports energy use associated with combustion only. The added Scope 3 energy use for these activities take into account upstream energy use (i.e. energy required for extraction, refining, etc.). The added energy is based on multipliers used in the GREET software, version 1.8d.1, which in this case equates to multiplying energy used in fuel combustion by 0.24 to calculate the upstream energy use.*

GSR Team Calculations to Split GHG Results from SiteWise into "Direct" and "Indirect"

phase	Reported by SiteWise		Assigned by GSR Team from SiteWise Output			Added by GSR Team	Total Calculated by GSR Team
			Scope 1 (direct)	Scope 2 (indirect)	Scope 3 (indirect)	Scope 3 (indirect)	
	activity	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	
site preparation (remedial investigation tab)	Consumables	0.63	0.00	0.00	0.63	0.00	0.63
	Transportation-Personnel	8.46	0.00	0.00	8.46	2.03	10.50
	Transportation-Equipment	0.93	0.00	0.00	0.93	0.22	1.15
	Equipment Use and Misc	121.13	121.13	0.00	0.00	29.07	150.20
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-Total	131.15	121.13	0.00	10.02	31.33	162.48
excavation, consolidation, and capping (remedial action construction tab)	Consumables	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	9.07	0.00	0.00	9.07	2.18	11.25
	Transportation-Equipment	0.79	0.00	0.00	0.79	0.19	0.98
	Equipment Use and Misc	448.21	448.21	0.00	0.00	107.57	555.78
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-Total	458.07	448.21	0.00	9.86	109.94	568.01
site restoration, grading, and installation of remedy infrastructure (remedial action operations tab)	Consumables	4.26	0.00	0.00	4.26	0.00	4.26
	Transportation-Personnel	4.69	0.00	0.00	4.69	1.13	5.82
	Transportation-Equipment	0.10	0.00	0.00	0.10	0.02	0.12
	Equipment Use and Misc	101.92	101.92	0.00	0.00	24.46	126.38
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-Total	110.97	101.92	0.00	9.05	25.61	136.58
LTM (longterm monitoring tab)	Consumables	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	6.20	0.00	0.00	6.20	1.49	7.68
	Transportation-Equipment	0.00	0.00	0.00	0.00	0.00	0.00
	Equipment Use and Misc	0.00	0.00	0.00	0.00	0.00	0.00
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-Total	6.20	0.00	0.00	6.20	1.49	7.68
Total		706.39	671.26	0.00	35.13	168.36	874.75

Note: For GHG emissions related to fuel use for transportation or on-site equipment use, SiteWise reports emissions associated with combustion only. The added Scope 3 emissions for these activities take into account upstream emissions (i.e. emissions related to extraction, refining, etc.). The added emissions factor is based on multipliers used in the GREET software, version 1.8d.1, which in this case equates to multiplying emission from fuel combustion by 0.24 to calculate the upstream emissions.

Institutional Controls - FFS costs (no updates in 30% Design)

updated fields highlighted in yellow					
DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
CAPITAL COSTS					
Environmental Covenant					
Env cov filing fees	1	lump sum (LS)	$200	$200	Engr's estimate
Env cov filing labor hours	40	hrs	$120	$4,800	Engr's estimate. It is assumed that bulk of the work needed for developing the env covs will be completed by CRAA. The hrs indicated here are primarily for review.
Subtotal				$5,000	
contingency	20%			$1,000	
Subtotal				$6,000	
TOTAL CAPITAL COST				**$6,000**	
OPERATION AND MAINTENANCE COST (Annual Cost)					
annual O&M		hrs		$0	
TOTAL O&M COST				**$0**	
PERIODIC COSTS					
renewals & replacements, year 5	1	LS	$0	$0	well replacement and/or maintenance
renewals & replacements, year 10	1	LS	$0	$0	20% of capital cost
renewals & replacements, year 15	1	LS	$0	$0	5-year review report = $40,000
renewals & replacements, year 20	1	LS	$0	$0	
renewals & replacements, year 25	1	LS	$0	$0	
renewals & replacements, year 30	1	LS	$0	$0	
			Total	$0	
TOTAL PERIODIC COST				**$0**	

LTM - FFS costs with updates (in yellow) from 30% Design

updated fields highlighted in yellow DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
CAPITAL COSTS					
Well Abandonment (4 onsite wells will be abndoned)					
mobilization and demobilization	1	lump sum (LS)	$1,000	$1,000	Engr's estimate
construction of temporary decon station	1	LS	$300	$300	Engr's estimate
well abandonment	4	per well	$800	$3,200	Design figures appear to indicate 4 wells will be abandoned
miscellaneous related to IDW disposal	1	LS	$1,000	$1,000	Engr's estimate
subtotal well abandonment				$5,500	
Well Installation (5 new wells and 4 replacement wells - avg depth 20 ft)					
mobilization and demobilization	1	LS	$1,000	$1,000	From a previous quote
construction of temporary decon station	1	LS	$1,000	$1,000	From a previous quote
construct 2" PVC wells (9 wells, 20 ft each)	9	LS	$2,000	$18,000	Will need to replace only 4 wells
install riser protective covers, pads	9	ea	$250	$2,250	Will need to replace only 4 wells
well development (4 hrs per well)	36	hrs	$110	$3,960	Will need to replace only 4 wells
miscellaneous related to IDW disposal	1	LS	$2,000	$2,000	From a previous quote
provide reconditioned drums	4	ea	$50	$200	From a previous quote
per diem (2 drillers plus 1 consultant)	5	day	$2,160	$10,800	From a previous quote
subtotal well installation				$39,210	
Subtotal				$44,710	
contingency	20%			$9,640	On construction
Subtotal				$54,350	
work planning, permitting, QA/QC plans and H&S requirements		LS		$15,000	
Subtotal				$69,350	
project management	15%			$10,926	On total cost, includes oversight labor
Subtotal				$80,276	
TOTAL CAPITAL COST				**$80,276**	From a previous quote
OPERATION AND MAINTENANCE COST (Annual Cost)					
Years 1 and 2 (quarterly sampling)					
GW Sampling (total 21 wells, 3 additional samples for QA/QC)					
groundwater sampling for VOCs (4 events/yr)	96	each	$95	$9,120	
groundwater sampling for SVOCs (4 events/yr)	96	each	$225	$21,600	
groundwater sampling for dioxins (4 events/yr)	96	each	$600	$57,600	
groundwater sampling for pesticides (4 events/yr)	96	each	$100	$9,600	
groundwater sampling for metals (4 events/yr)	96	each	$125	$12,000	
groundwater sampling, level D	4	LS	$300	$1,200	
labor (prep & sampling)	240	hours	$110	$26,400	60 hrs/event
equipment - meters	4	LS	$300	$1,200	
consumables	4	LS	$200	$800	
data validation	72	hours	$120	$8,640	12 hrs/event + 24 hrs for initial event
subtotal annual O&M (Yr 1 to 2) - quarterly sampling				$148,160	
Years 3,4, and 5 (semiannual sampling)					
GW Sampling (total 21 wells, 3 additional samples for QA/QC)					
groundwater sampling for VOCs (2 events/yr)	48	each	$95	$4,560	Analytical costs
groundwater sampling for SVOCs (2 events/yr)	48	each	$225	$10,800	Analytical costs
groundwater sampling for dioxins (2 events/yr)	48	each	$600	$28,800	Analytical costs

LTM - FFS costs with updates (in yellow) from 30% Design

updated fields highlighted in yellow					
DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
groundwater sampling for pesticides (2 events/yr)	48	each	$100	$4,800	Analytical costs
groundwater sampling for metals (2 events/yr)	48	each	$125	$6,000	Analytical costs
groundwater sampling, level D	2	LS	$300	$600	
labor (prep & sampling)	120	hours	$110	$13,200	60 hrs/event (2 people for 3 10-hr days)
equipment - meters	2	LS	$300	$600	
consumables	2	LS	$200	$400	
data validation	32	hours	$120	$3,840	12 hrs/event
subtotal annual O&M (Yr 3 to 5) - semi-annual sampling				$73,600	
subtotal annual O&M (Yr 6 to 30)				$36,800	(Annually)
reporting (1 annual report)	1	LS	$15,000	$15,000	
contingency (yr 1 to 2)	20%			$32,632	
contingency (yr 3 to 5)	20%			$17,720	
contingency (yr 6 to 30)	20%			$10,360	
Subtotal Annual O&M (yr 1 to 2)				$195,792	
Subtotal Annual O&M (yr 3 to 5)				$106,320	
Subtotal Annual O&M (yr 6 to 30)				$62,160	
project management (yr 1 to 2)	15%			$29,369	
project management (yr 3 to 5)	15%			$15,948	
project management (yr 6 to 30)	15%			$9,324	
TOTAL ANNUAL O&M COST Year 1 to 2				**$225,200**	
TOTAL ANNUAL O&M COST Year 3 to 5				**$122,300**	
TOTAL ANNUAL O&M COST Year 6 to 30				**$71,500**	
PERIODIC COSTS					
renewals & replacements (includes 5-yr reiew report), year 5	1	LS	$61,568	$61,568	well replacement and/or maintenance
renewals & replacements (includes 5-yr reiew report), year 10	1	LS	$62,861	$62,861	20% of capital cost
renewals & replacements (includes 5-yr reiew report), year 15	1	LS	$64,181	$64,181	5-year review report = $40,000
renewals & replacements (includes 5-yr reiew report), year 20	1	LS	$65,529	$65,529	
renewals & replacements (includes 5-yr reiew report), year 25	1	LS	$66,905	$66,905	
renewals & replacements (includes 5-yr reiew report), year 30	1	LS	$68,310	$68,310	
			Total	$389,354	
TOTAL PERIODIC COST				**$389,400**	

Consolidation and Soil Cover - FFS costs with updates (in yellow) from 30% Design

updated fields highlighted in yellow

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
CAPITAL COSTS					
Waste Consolidation - Clearing AOC 1 and AOC 2					
mobilization and demobilization	1	lump sum (LS)	$15,000	$15,000	Engr's estimate
fence cost (includes removal of existing fence and installation of new fence arou	1	LS	$100,000	$100,000	Engr's estimate
vegetation removal - heavy brush, light trees, clear, chip, grub, and hau	55.7	acres	$6,500	$362,050	Total acreage of excavation areas 1-5, borrow area, and area to be capped (minus overlap
excavation and relocation fo waste materials to be consolidated	140000	yd^3	$6	$840,000	Total waste excavated from areas 1-5
decontamination	1	LS	$4,000	$4,000	CCI 2010
backfill - borrow from onsite source	23861	yd^3	$5	$119,305	Backfill for areas 3 and 4 will come from an onsite source and will cost $5/$yd^3$ to place/grade
subtotal waste consolidation				$1,440,355	
Soil Cover Installation					
mobilization and demobilization	1	each	$15,000	$15,000	Engr's estimate
monitoring with PID reader	4	month	$1,300	$5,200	
grading	119548	square yards	$2	$239,096	24.7 acres of capped area will be graded to 4% slope
soil cover placement (6-inch lifts, 24-inch total depth)	88000	yd^3	$5	$440,000	Soil for landfill cap will come from an onsite source and will cost $5/$yd^3$ to place/grade
topsoil (6-inch topsoil layer over landfill cover)	20500	yd^3	$5	$102,500	Clean topsoil from excavated areas will be stripped, stockpiled, and re-used; it will cost $5/$yd^3$ to place/grade
hydroseeding/mulching and vegetative establishment	46.7	acres	$3,528	$164,758	Revegetation over capped area (24.7 acres) and borrow area (22 acres)
topographic survey (2-foot contours)	1	LS	$40,000	$40,000	
decontamination	1	LS	$10,000	$10,000	
subtotal soil cover installation				$1,016,554	
Passive Landfill Gas Management					
total installed cost per vent	25	each	$600	$15,000	CCI 2010
subtotal passive vent installation				$15,000	
Subtotal				$2,471,909	
contingency	20%			$1,483,044	
Subtotal				$3,954,953	
work planning, permitting, QA/QC plans and H&S requirements and landfill closu	1	LS	$100,000	$100,000	
Subtotal				$4,054,953	
construction management	15%			$1,349,740	includes oversight labor
Subtotal				$5,404,693	
TOTAL CAPITAL COST				**$5,404,693**	
OPERATION AND MAINTENANCE COST (Annual Cost)					
Cap Maintenance					
biannual inspection	16	hour	$100	$1,600	
biannual mowing (labor plus equipment) (40 acres plus surrounding	96	acres	$50	$4,800	
annual minor repairs	1	LS	$5,000	$5,000	
subtotal cap maintenance				$11,400	
Subtotal Annual O&M				$11,400	
reporting (included elsewhere)				$0	
contingency	20%			$2,280	
TOTAL ANNUAL O&M COST				**$13,700**	
PERIODIC COSTS					
renewals & replacements, year 5	1	LS	$15,000	$15,000	
renewals & replacements, year 10	1	LS	$15,315	$15,315	
renewals & replacements, year 15	1	LS	$15,637	$15,637	
renewals & replacements, year 20	1	LS	$15,965	$15,965	
renewals & replacements, year 25	1	LS	$16,300	$16,300	
renewals & replacements, year 30	1	LS	$16,643	$16,643	
			Total	$94,859	
TOTAL PERIODIC COST				**$95,000**	

Project: GSR Pilot for Lockbourne Landfill
Option or Alternative: Baseline Option (Consolidation and Capping)
Current Date: 5/3/2011

year	up-front cost	annual cost	present value of cost each year	cumulative cash flow	
		(no discounting)	2.7%	no discounting	2.7%
0	$3,611,184	$0	$3,611,184	$3,611,184	$3,611,184
1	$0	$238,841	$232,562	$3,850,025	$3,843,746
2	$0	$238,841	$226,448	$4,088,866	$4,070,194
3	$0	$135,948	$125,505	$4,224,814	$4,195,699
4	$0	$135,948	$122,206	$4,360,762	$4,317,904
5	$0	$212,516	$186,011	$4,573,278	$4,503,916
6	$0	$85,164	$72,583	$4,658,442	$4,576,498
7	$0	$85,164	$70,675	$4,743,606	$4,647,173
8	$0	$85,164	$68,816	$4,828,770	$4,715,989
9	$0	$85,164	$67,007	$4,913,934	$4,782,997
10	$0	$163,340	$125,138	$5,077,274	$4,908,134
11	$0	$85,164	$63,530	$5,162,438	$4,971,665
12	$0	$85,164	$61,860	$5,247,602	$5,033,525
13	$0	$85,164	$60,234	$5,332,766	$5,093,759
14	$0	$85,164	$58,650	$5,417,930	$5,152,409
15	$0	$164,982	$110,632	$5,582,912	$5,263,041
16	$0	$85,164	$55,607	$5,668,076	$5,318,648
17	$0	$85,164	$54,145	$5,753,240	$5,372,793
18	$0	$85,164	$52,722	$5,838,404	$5,425,514
19	$0	$85,164	$51,335	$5,923,568	$5,476,850
20	$0	$166,658	$97,818	$6,090,226	$5,574,667
21	$0	$85,164	$48,672	$6,175,390	$5,623,339
22	$0	$85,164	$47,392	$6,260,554	$5,670,731
23	$0	$85,164	$46,146	$6,345,718	$5,716,877
24	$0	$85,164	$44,933	$6,430,882	$5,761,810
25	$0	$168,369	$86,497	$6,599,251	$5,848,307
26	$0	$85,164	$42,601	$6,684,415	$5,890,909
27	$0	$85,164	$41,481	$6,769,579	$5,932,390
28	$0	$85,164	$40,391	$6,854,743	$5,972,781
29	$0	$85,164	$39,329	$6,939,907	$6,012,110
30	$0	$170,117	$76,495	$7,110,024	$6,088,605

Net Present Value (NPV)-> $6,088,605

*positive dollar value is a "cost", negative dollar value is a "savings"

FINAL REPORT

PILOT PROJECT
GREEN AND SUSTAINABLE REMEDIATION EVALUATION:
BLUE MOUNTAIN TRAINING AREA, FORT MISSOULA
MISSOULA, MONTANA

Prepared for:

U.S. Army Corps of Engineers
Environmental and Munitions Center of Expertise
1616 Capitol Ave, Suite 9200
Omaha, NE 68101-9200

Contract No. W912DQ-08-D-0019
Delivery Order No. ZW02

Prepared by:

Tetra Tech EC, Inc.
1000 American Rd.
Morris Plains, NJ 07950

21 December 2011

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Appendix A: Best Management Practice (BMP) Tables

Appendix B: Assumptions for SiteWise Input and Other Calculations, BMTA GSR Evaluation: Alternative 1 – Planned RI/FS Activities

PREFACE

The US Army Engineering and Support Center, Huntsville (USAESCH), Environmental and Munitions Center of Expertise (EM CX) has contracted Tetra Tech EC, Inc. (Tetra Tech) under Contract W912DQ-08-D-0019, Delivery Order No. ZW02, to conduct and document a Study that follows the process of considering, incorporating, documenting, and evaluating the benefits of green and sustainable remediation (GSR) practices. The objective of this Task Order is to: (1) Follow the consideration and incorporation of GSR practices into Army environmental remediation projects; (2) Ascertain the effectiveness of the GSR practices that are considered and incorporated; and (3) Provide procedures by which GSR practices that are shown to be effective can be identified, considered, implemented and documented by Project Teams working on Army sites. The information obtained from this Study will be used to provide recommendations to the Office of the Assistant Chief of Staff for Installation Management (OACSIM) for development of Army-wide GSR guidance and policy. This document has been prepared in accordance with the Task Order Statement of Work (SOW) entitled "*Evaluation of Consideration and Incorporation of Green and Sustainable Remediation (GSR) Practices in Army Environmental Remediation*" (26 July 2010).

The Project Delivery Team (PDT) consists of representatives and subject matter experts (SMEs) from the following organizations:

- EM CX;
- OACSIM;
- National Guard Bureau (NGB);
- Army Environmental Command (AEC);
- Tetra Tech;
- Office of the Deputy Assistant Secretary of the Army-Environment, Safety, and Occupational Health (ODASA (ESOH));
- Headquarters US Army Corps of Engineers (HQ USACE) Formerly Used Defense Sites (FUDS) program;
- HQ USACE Environmental Community of Practice (ECoP) Military Munitions Support Services (M2S2);
- Huntsville Center Environmental Program; and
- Army Environmental Policy Institute (AEPI)

Specific representatives of those organizations are listed on the table at the end of this preface. This report pertains to one of the pilot projects conducted as part of the Study. Tetra Tech personnel who provided the most significant contributions to this report are as follows:

- Preparation
    - Rob Greenwald (Project Manager)
    - Sarah Farron

- Review
    - Michelle Caruso (MMRP Lead)

Sincere thanks are extended to the Project Team associated with this pilot project, for their willingness to participate in this Study and for their efforts that were associated with their participation.

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Professional in Charge:

Doug Sutton, PhD, PE, LEED

____12/21/11____
Date

ACRONYMS AND ABBREVIATIONS

ACSIM	Assistant Chief of Staff for Installation Management
AEC	Army Environmental Command
AEPI	Army Environmental Policy Institute
ATV	All-Terrain Vehicle
BIP	Blow-in-Place
BMPs	Best Management Practices
BMRA	Blue Mountain Recreation Area
BMTA	Blue Mountain Training Area
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CO2	Carbon Dioxide
CO2e	Equivalent Global Warming Potential of Carbon Dioxide
CSM	Conceptual Site Model
DERP	Defense Environmental Restoration Program
DGM	Digital Geophysical Mapping
DMM	Discarded Military Munitions
DoD	Department of Defense
ECoP	Environmental Community of Practice
EM	Electromagnetic
EM CX	Environmental and Munitions Center of Expertise
EPA	Environmental Protection Agency
ESOH	Environment, Safety, and Occupational Health
ESP	Explosives Site Plan
FS	Feasibility Study
FUDS	Formerly Used Defense Sites
GHG	Greenhouse Gas
GPS	Global Positioning System
GSR	Green and Sustainable Remediation
GTS	Grenade Training Site
HFD	Hazardous Fragment Distance
HQ USACE	Headquarters US Army Corps of Engineers
HRR	Historical Records Review
HRS	Hours
IRP	Installation Restoration Program
ISM	Incremental Sampling Methodology
Kg	Kilograms
lbs	Pounds
M2S2	Military Munitions Support Services
MC	Munitions Constituents
MDEQ	Montana Department of Environmental Quality
MEC	Munitions and Explosives of Concern
MFR-H	Maximum Fragmentation Range – Horizontal
MGFD	Munition with the Greatest Fragmentation Distance
MMBtu	Million Metric British Thermal Units
MMRP	Military Munitions Response Program
MRS	Munitions Response Site
MTARNG	Montana Army National Guard
NGB	National Guard Bureau
NOx	Nitrogen Oxides

ACRONYMS AND ABBREVIATIONS

NPV	Net present value
O&M	Operations and Maintenance
OACSIM	Office of the Assistant Chief of Staff for Installation Management
ODASA	Office of the Deputy Assistant Secretary of the Army
PA	Preliminary Assessment
PDT	Project Delivery Team
PM	Particulate Matter
POTW	Publicly Operated Treatment Works
PRGs	Preliminary Remediation Goals
RECs	Renewable Energy Certificates
RI	Remedial Investigation
RI/FS	Remedial Investigation / Feasibility Study
ROTC	Reserve Officers' Training Corps
SI	Site Investigation or Site Inspection
SiteWise	Battelle SiteWise™ Sustainable Environmental Remediation Tool
SMEs	Subject Matter Experts
SOW	Statement of Work
SOx	Sulfur Oxides
SSLs	Soil Screening Levels
TPP	Technical Project Planning
US	United States
USACE	United States Army Corps of Engineers
USAESCH	US Army Engineering and Support Center, Huntsville
USFS	US Forest Service
UXO	Unexploded Ordnance
VCRA	Voluntary Cleanup and Redevelopment Act
VFD	Variable Frequency Drive
XRF	X-Ray Fluorescence

1.0 INTRODUCTION

1.1 ACSIM GSR STUDY AND PURPOSE OF THIS GSR EVALUATION

The US Army Engineering and Support Center, Huntsville (USAESCH), Environmental and Munitions Center of Expertise (EM CX) has contracted Tetra Tech EC, Inc. (Tetra Tech) under Contract W912DQ-08-D-0019, Delivery Order No. ZW02, to conduct and document a Study that follows the process of considering, incorporating, documenting, and evaluating the benefits of green and sustainable remediation (GSR) practices (hereafter referred to as "the Study"). Pursuant to the Department of Defense (DoD) Memorandum "*Consideration of Green and Sustainable Remediation Practices in the Defense Environmental Restoration Program*" (DoD, 2009), GSR employs strategies throughout the remedial process that:

- Use natural resources and energy efficiently;
- Reduce negative impacts on the environment;
- Minimize or eliminate pollution at its source;
- Protect and benefit the community at large; and
- Reduce waste to the greatest extent possible.

The objective of the Study is to: (1) Follow the consideration and incorporation of GSR practices into Army environmental remediation projects; (2) Ascertain the effectiveness of the GSR practices that are considered and incorporated; and (3) Provide procedures by which GSR practices that are shown to be effective can be identified, considered, implemented and documented by Project Teams working on Army sites. The information obtained from this Study will be used to provide recommendations to the Office of the Assistant Chief of Staff for Installation Management (OACSIM) for development of Army-wide GSR guidance and policy.

One component of the Study is to perform a GSR evaluation at 12 Army "Pilot Projects" that are in various phases of the remedial process. This report presents the Pilot Project GSR Evaluation for the Blue Mountain Training Area (BMTA) at Fort Missoula in Missoula, Montana. This GSR evaluation has been conducted using an approach developed during the Study and documented in the following report: *Process for Consideration and Incorporation of Green and Sustainable Remediation (GSR) Practices in Army Environmental Remediation (final report dated 26 May 2011).* One purpose for the pilot projects is to provide testing of the GSR approach developed during the Study. That approach will be refined and finalized later in the Study based on lessons learned from this and other pilot projects. In addition, it is anticipated that this GSR evaluation will provide the Project Team for BMTA with information and/or recommendations that will be beneficial for their project.

This report refers to "teams" that are defined as follows:

- Study Team: This is the team conducting the Study being led by USACE EM CX that follows the process of considering, incorporating, documenting, and evaluating the benefits of GSR practices for Army projects.
- Project Team: Refers to those associated with implementation of the remedial process for each pilot project.

- GSR Team: Refers to the personnel that perform a specific GSR evaluation. For this Study, the GSR Team consists of personnel from Tetra Tech, which is a contractor to USACE for the Study.

In this Study, an "EM CX liaison" for each of the pilot projects serves as a bridge between the USACE Study project manager (Carol Dona), the Study contractor performing the GSR evaluation (Tetra Tech), and the Project Team manager for the specific pilot. For this pilot project, MAJ Kim Gage served as the Army National Guard liaison during the initial planning phases, and Nick Stolte served as the EM CX liaison during the execution of the GSR evaluation.

1.2 TECHNICAL OVERVIEW

1.2.1 <u>Overview of Site Location and Setting</u>

This GSR evaluation pertains to Remedial Investigation/Feasibility Study (RI/FS) activities associated with characterizing the nature and extent of munitions and explosives of concern (MEC) and munitions constituents (MC) at the Blue Mountain Training Area (BMTA) Munitions Response Site (MRS) in Missoula, Montana. The BMTA is associated with Fort Missoula, which is located in the southwest portion of Missoula, Montana, in Missoula County, in the west-central part of Montana. The locations of Fort Missoula and the BMTA MRS are illustrated on Figure 1-1. The original BMTA was approximately 1,181 acres; however, previous investigations and historical records review have limited the area of the BMTA MRS to a much smaller area consisting of approximately 296.8 acres. The BMTA is located approximately 2 miles southwest of the present Fort Missoula property, across the Bitterroot River, and is located within the US Forest Service (USFS) Lolo National Forest Blue Mountain Recreation Area (BMRA).

The BMTA was formerly used by the Department of the Army for military training. A brief summary of the BMTA history is provided below:

- 1942 - Land purchased by Missoula Chamber of Commerce and turned over to the military for training.

- 1952 - Land transferred by Executive Order to Lolo National Forest allowing continued military training until 1992 under a Memorandum of Understanding between the Army and the USFS Missoula Ranger District.

- 1986 - Live fire training ended.

- 1986 to present - Army ROTC uses portions of the area for land navigation training.

Locations of ranges associated with previous munitions training are illustrated on Figure 1-2 and included the following (discussed in more detail in Section 1.2.2):

- Pistol Range;

- M16/M60 Range;

- Demolition Range;

- M203/M79 Range and Impact Area; and
- Grenade Training Range and Impact Area.

The Montana Army National Guard (MTARNG), which has had a presence at Fort Missoula since April of 1968, contracted Weston Solutions (Weston) to conduct the RI/FS. To accomplish the RI/FS field program, MTARNG and Weston coordinate extensively with the USFS because the Blue Mountain Recreation Area (BMRA), which is operated by USFS and encompasses the BMTA, is an active recreation area that experiences heavy daytime use by walkers, joggers, dog walkers, hikers, and horseback riders.

1.2.2 Contamination, Remedial Phase and Status

The RI/FS at the BMTA MRS is a project conducted within the Military Munitions Response Program (MMRP). In 1986 Congress established the Defense Environmental Restoration Program (DERP) to provide for the cleanup of Department of Defense (DoD) sites. In 2002 Congress established the MMRP under DERP to address unexploded ordnance (UXO), discarded military munitions (DMM) and munitions constituents (MC) located on current and Formerly Used Defense Sites (FUDS). Generally, MMRP remedies are conducted under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). The process to investigate and clean up potential munitions-related contamination at the BMTA under MMRP and CERCLA was initiated in 2003, and a summary of the progress to date includes the following:

- 2003–Range Inventory Report for Fort Missoula completed, as part of the Preliminary Assessment (PA) phase of work under CERCLA.
- 2007–Historical Records Review (HRR) completed for Fort Missoula to supplement the Range Inventory Report and identify data gaps to determine the next steps in the CERCLA process.
- 2008–Site Investigation (SI) completed to determine the presence or absence of contamination from former military training activities at the site. Results from the SI for BMTA confirmed the potential for munitions-related contamination due to past training activity and an RI/FS was recommended as the next step in the CERCLA process.
- 2010–RI/FS planning process initiated.
- 2011–RI/FS field work to begin.

Based on information obtained during the SI, the following ranges and associated munitions were likely used at the site (see Figure 1-2):

- Pistol Range: Range mainly used for small arms training; however, 3.5-inch rocket heads (identified as practice rounds Model M29A2) were observed during the SI at the pistol range firing point/backstop berm and impact area downrange on the hillside. There is also the potential for burial of DMM.
- M16/M60 Range: This was a small arms range used for M16, M60, and the .45-caliber submachine gun.

- Demolition Range: The demolition range is located within the footprint of the M16/M60 range. The range was likely used for demolition training; however, the use of the range has not been fully determined. The HRR indicates the primary release mechanism as unfired demolition shots inadvertently left behind. Potential munitions included fuzes (electric and non-electric), demolition blocks, time fuzes, shaped charges (15-pound [lb] and 40-lb), 40-lb cratering charge and detonating cord.

- M203/M79 Range and Impact Area: Range was used for rifle grenade training with practice M79 and 40mm grenades.

- Grenade Training Range and Impact Area: Range was used for live hand thrown grenades.

The SI field activities included magnetometer (Schonstedt)-assisted visual survey with meandering paths in the selected areas to cover approximately 10% in impact areas and approximately 1% in other areas. No MEC was reportedly found. Five composite soil samples were collected and analyzed to assess the potential for MC. No explosives were reported in any of the collected MC samples; however, iron detections were reported to exceed the US Environmental Protection Agency (EPA) Preliminary Remediation Goals (PRGs), the EPA Soil Screening Levels (SSLs), and the MDEQ VCRA screening level. Lead was also detected in samples collected from the pistol range backstop at levels that exceeded the screening criteria. The SI recommended further investigation of MEC and MC in an RI, because historical information indicated training occurred at the site, and observations of munitions debris at the site confirm range usage.

The purpose of the RI/FS project is to define the nature and extent of contamination, and better understand associated risks from past military activities at the site including potential contamination in soil. The RI/FS project involves the following components:

- Work Plan development including overall work plan, health and safety plan, and project schedule;

- Public involvement and outreach during the entire project;

- A field investigation to define the nature and extent of MEC and MC on the ground surface and within the subsurface through field surveys and soil sampling;

- Risk assessment to assess the threat to human health, safety, and the environment; and

- Preparation of an RI/FS report with recommendations for next steps including potential remedial alternatives.

The field investigation component of the RI is expected to be completed in 2011. This GSR evaluation provides an evaluation of the planned RI activities with respect to specific GSR metrics, and also highlights how specific GSR Best Management Practices (BMPs) have been implemented in previous remedial activities and/or could be implemented during upcoming RI activities. However, this GSR evaluation does not in any manner include an evaluation or judgment of the protectiveness of the remedial activities.

1.2.3 <u>Overview of Planned RI Field Activities</u>

Based on a review of the RI/FS Work Plan, information conveyed during the 17 May 2011 public meeting, and discussions during the 18 May 2011 meeting with the Project Team, planned field activities associated with the RI include the following:

- *<u>Trail System Investigation</u>*. Analog metal detector-aided surveys will be conducted on the trail system at the BMTA using handheld all-metals detectors to look for buried munitions items at the site. Locations of any identified anomalies will be recorded using global positioning system (GPS) units. The maximum width covered by the teams will be approximately 28-ft wide. UXO technicians will survey approximately 8 miles of trails at BMTA. Any large concentrations of metallic anomalies identified during the analog detector-aided surveys along the trails, especially near former training ranges, will be intrusively investigated. This information will provide comprehensive information regarding the risks to public users on the BMRA trails, as well as additional data for focused geophysical surveys.

- *<u>Focused Geophysical Surveys of Former Ranges</u>*. Digital Geophysical Mapping (DGM) electromagnetic (EM) surveys will be conducted at specified grid locations within the RI/FS project area to detect subsurface metallic anomalies such as steel and brass that may be indicative of MEC. Preliminary DGM grid locations are illustrated on Figure 1-2. The locations of any items identified during the DGM surveys will be documented with GPS instrumentation so the locations of all buried items can be re-located later in the project if selected for intrusive investigations. This includes the following process:

    - Perform site preparation activities including surface sweeps and brush clearing to reduce surface hazards related to MEC and facilitate geophysical data collection. An exclusion zone will be established for each investigation area based on the hazardous fragment distance (HFD) of the munition with the greatest fragmentation distance (MGFD) during the surface sweep task and any subsequent task that may involve encountering MEC. The exclusion zone will be patrolled to ensure non-essential personnel (e.g., trespassers or BMRA visitors) do not violate the exclusion zone.

    - Conduct DGM survey (non-intrusive) to locate subsurface metallic anomalies. Exclusion zone is not needed during DGM surveys or other non-intrusive work.

    - Review the DGM data and determine which items are to be intrusively investigated.

    - Re-establish the applicable exclusion zone based on the HFD, re-locate and intrusively investigate the items selected by the geophysicist to determine if they are UXO, DMM, Munitions Debris, or trash.

    - Establish the exclusion zone based on the maximum fragmentation range – horizontal (MFR-H) of the recovered MEC. Dispose of the item through blow-in-place (BIP) procedures as described below.

- *<u>Munitions Constituent (MC) Soil Sampling</u>*. Soil sampling for MC, such as chemical compounds from explosives or lead from small arms ammunition, will be conducted to evaluate the nature and extent of MC within the RI/FS project area. Sample locations will be documented by GPS coordinates and by photographing sampling activities. Sampling methodologies that may be employed at the former ranges include:

- Incremental Sampling Methodology (ISM) – This will be the primary sampling methodology for collecting surface soil samples for metals and explosives analyses by an off-site laboratory. ISM will be conducted at the hand grenade and M203 impact areas, demolition range, firing points, small arms target areas, and other locations based on field observations. Samples will be collected at a minimum of 32 locations for lead and explosives analyses as well as other areas as needed as part of contingency sampling. An ISM tool will be used to collect the ISM samples and will be decontaminated between samples. Disposable surgical gloves will be used for sample collection and handling.

- Discrete sampling – A total of 104 discrete samples are planned for the small arms ranges (Pistol and M16/M60) and two background area for analysis of lead at an off-site laboratory. Disposable sampling equipment (plastic scoops and resealable plastic bags) will be used to collect discrete samples. Disposable surgical gloves will be used for sample collection and handling.

- Contingency sampling – Based on field observations, ISM, discrete, and/or composite sampling will be conducted as needed for metals and/or explosives. Sampling will be conducted throughout the RI/FS project area as needed and samples will be submitted to an off-site laboratory for analysis. Disposable sampling equipment (plastic scoops and resealable plastic bags) will be used to collect composite samples. Disposable surgical gloves will be used for sample collection and handling.

- Field screening X-Ray Fluorescence (XRF) – This is a method for analysis of lead in soil while in the field. Some samples are confirmed by an off-site laboratory. Sampling areas may include small arms ranges based on field observations.

- *UXO Disposal (if needed)*. If UXO is identified during the field investigation, specific safety procedures outlined in an Explosive Site Plan (ESP) will be implemented to ensure public safety and the safety of the RI/FS Project Team. The approach for disposal of recovered UXO will be to BIP, which involves the use of donor explosives to destroy the UXO item where it was found on the day in which it was encountered. If the recovered UXO cannot be destroyed on the day in which it was recovered, it will be guarded until BIP procedures can be performed. Donor explosives will be stored near the site at the Sheriff's office, and will be transported by the Sheriff's office if explosives are needed. Specific BIP procedures include:

  - Notification to the MTARNG, USFS and Sheriff's Office;

  - The exclusion zone will be modified based on the MFR-H and the specifications for the approved engineering control and guarded at all times around the UXO item in accordance with the ESP to maintain public safety;

  - Appropriate engineering controls, such as covering the UXO item with sandbags, will be used to mitigate the blast and explosive hazards and minimize damage to the surrounding area based on the specifications outlined in the ESP; and

- After the BIP operation, the UXO item will be inspected by the UXO Team to ensure that explosive hazard has been neutralized and that all materials leaving the site are documented as "safe" prior to offsite disposal or recycling, according to DoD regulations.

The Project Team indicated that any unused sandbags will be beneficially re-used by MTARNG, and any unused explosives will be donated to the Sheriff's office for future beneficial use (i.e., they will not be wasted or consumed in a final BIP if not used during the RI).

1.3 DOCUMENTS REVIEWED AND CALLS/MEETINGS CONDUCTED

The following project documents were reviewed for this evaluation:

- *Draft Work Plan: Military Munitions Response Program Remedial Investigations and Feasibility Studies; Grenade Training Site and Blue Mountain Training Area, Fort Missoula, Missoula, Montana* (Weston, February 2011)

- *Fort Missoula/Fort Harrison Munitions Response Sites RI/FS Schedule* (Weston, 13 January 2011)

- PDF files downloaded from the following public website for the BMTA RI: http://www.bluemountainrifs.org/

Pursuant to the GSR approach implemented in the Study, an introductory conference call (referred to as the "Step 3" call) was conducted on 11 March 2011. A second "Step 3" call was conducted on 1 April, 2011. This second call included participants from the MTARNG who are conducting the RI/FS, and was conducted so that the GSR Team and the Project Team could thoroughly discuss integration of the GSR evaluation into the RI/FS project schedule. Items discussed on these two introductory calls included the following:

- The schedule of the GSR evaluation within the context of how the GSR evaluation could best be integrated into the overall efforts and schedule of the Project Team.

- A subsequent "Step 5" meeting, which would serve as a primary mechanism for the GSR Team and Project Team to exchange information and ideas, was scheduled for 17 and 18 May 2011 to coincide with a public meeting and a Technical Project Planning (TPP) meeting.

Participants for the first "Step 3" call are listed in Table 1-1.

Table 1-1
Step 3 Call Participants, 11 March 2011

Participants			
Name	**Organization**	**Phone**	**Email**
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Sarah Farron	Tetra Tech	732.409.0344	sarah.farron@tetratech.com

Participants for the second "Step 3" call are listed in Table 1-2.

Table 1-2
Step 3 Call Participants, 1 April 2011

Participants			
Name	**Organization**	**Phone**	**Email**
Carol Dona	EM CX	402.697.2582	Carol.L.Dona@usace.army.mil
Nick Stolte	EM CX	256.895.1595	Nicholas.J.Stolte@usace.army.mil
Kevin Roughgarden	OACSIM	703.601.1551	kevin.roughgarden@conus.army.mil
MAJ Kim Gage	NGB	703.601.7984	Kim.Gage@us.army.mil
Rob Halla	NGB	703.607.7995	Rob.Halla@us.army.mil
Sundi West	MTARNG	406.324.3088	Sundi.West@us.army.mil
Clif Youmans	MTARNG	406.324.3085	Clifton.Youmans@us.army.mil
Rob Greenwald	Tetra Tech	732.409.0344	rob.greenwald@tetratech.com
Michelle Caruso	Tetra Tech	973.630.8128	Michelle.Caruso@tetratech.com
Sarah Farron	Tetra Tech	732.409.0344	sarah.farron@tetratech.com

A public meeting conducted on 17 May 2011 was attended by the GSR Team, and the discussion of GSR considerations was held on 18 May 2011. During this meeting the GSR Team used the list of GSR BMPs developed for the Study as an outline to ask the Project Team questions about the field investigation components and allow the Project Team to provide pertinent information to the GSR Team. Participants for this meeting are listed in Table 1-3.

Table 1-3
Step 5 Meeting Participants, 18 May 2011

Participants			
Name	**Organization**	**Phone**	**Email**
Clif Youmans	MTARNG	406.324.3085	Clifton.Youmans@us.army.mil
Sundi West	MTARNG	406.324.3088	Sundi.West@us.army.mil
Rob Halla	NGB	703.607.7995	Rob.Halla@us.army.mil
Mark Bell	Weston	303.619.3781	mark.bell@westonsolutions.com
Michael Mason	Weston	256.825.4650	michael.mason@westonsolutions.com
Cheryl Chapman	Matrix	605.399.2000	ckchapman@matrixcgi.com
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Paul Matter	USFS	406.329.3948	pmatter@fs.fed.us
Nick Stolte	EM CX	256.895.1595	Nicholas.J.Stolte@usace.army.mil
Rob Greenwald	Tetra Tech	732.409.0344	rob.greenwald@tetratech.com
Michelle Caruso	Tetra Tech	973.630.8128	Michelle.Caruso@tetratech.com

Note: Weston is a contractor to MTARNG, and Matrix is a subcontractor to Weston

Subsequent to the Step 5 meeting, the Project Team provided the GSR Team (via email) with estimates regarding transportation to be used for the quantitative footprinting portion of the GSR evaluation.

1.4 STRUCTURE OF THIS REPORT

This GSR evaluation report is structured as follows:

- Section 1: Introduction
- Section 2: Key GSR Findings
  - Review of BMPs
  - Quantitative Footprint Analysis for Planned RI Activities
  - Other Qualitative Considerations
- Section 3: GSR Recommendations

Supporting information and calculations for quantitative aspects of the evaluation are provided in appendices, and spreadsheet files for the SiteWise tool are attached electronically.

2.0 KEY GSR FINDINGS

2.1 REVIEW OF BEST MANAGEMENT PRACTICES (BMPs)

2.1.1 BMP Tables Completed by GSR Team

The GSR Team and the Project Team used a list of GSR BMPs as an outline to exchange information and ideas pertinent to application of GSR practices for this pilot project. The GSR Team subsequently completed the BMP tables included in Appendix A, based on the data provided by the Project Team in the form of documents as well as discussions during the Step 5 meeting and site visit. Table 2-1 summarizes information entered on the BMP tables in Appendix A, specifically with respect to the number of BMPs that appear to be applicable for this pilot project, the number of BMPs that appear to be practical for this pilot project, the number of BMPs that have been implemented prior to this GSR evaluation, and the number of BMPs that maybe associated with potential cost savings for this pilot project.

Table 2-1
Summary of BMP Applicability and Implementation from BMP Tables in Appendix A

	BMP Category								
	A. Planning	B. Characterization and/or Remedy Approach	C. Energy/Emissions Transportation	D. Energy/Emissions Equipment Use	E. Materials & Off-site Services	F. Water Resource Use	G. Waste Generation, Disposal, and Recycling	H. Land Use, Ecosystems, and Cultural Resources	I. Safety and Community
Total Number of BMPs	10	9	4	11	5	5	6	7	7
Number of Applicable BMPs	9	8	4	9	2	1	2	5	3
Number of Practical BMPs	9	8	4	8	2	1	2	5	3
Number of BMPs Implemented Prior to GSR Evaluation									
- Fully	9	8	4	1	2	1	2	5	3
- Partially	0	0	0	0	0	0	0	0	0
- Not Yet	0	0	0	0	0	0	0	0	0
Number of Practical BMPs Likely to Result in Cost Savings	4	7	4	0	2	0	1	1	0

2.1.2 Key Findings Regarding BMPs

An overview of key findings regarding application of the BMPs to this pilot project is provided below.

- The Project Team has extensively considered GSR principles in developing the RI/FS Work Plan, and has already included a page entitled "Sustainability Commitment" on the project website that is available to the public. The RI/FS project website (www.BlueMountainRIFS.org) includes the following:

  - Weston will accomplish the goals of energy conservation by minimizing energy consumption (e.g., use energy efficient equipment), powering cleanup equipment through onsite renewable energy sources where available, and purchasing commercial energy from renewable resources. To improve air quality, Weston will create benefits by minimizing the generation of greenhouse gases, minimizing generation and transport of airborne contaminants and dust, using heavy equipment efficiently (e.g., use a diesel emission reduction plan), maximizing the use of machinery equipped with advanced emission controls, and using cleaner fuels to power machinery and auxiliary equipment.

  - Weston will attempt to accomplish the goals of water conservation by minimizing water use and depletion of the natural water resources, capturing, reclaiming and storing water for reuse, minimizing water demand for revegetation (e.g., using native species or grasses that are drought tolerant), and employing best management practices for stormwater management and sedimentation controls where excavation activities are performed.

  - The goals of the materials use and waste minimization core element will be accomplished by minimizing all investigative and remedial wastes and attempting to incorporate recovered materials into recycling or reuse programs. Weston will strive to provide land and ecosystem benefits by integrating anticipated site use or reuse plans into the cleanup strategy, minimizing areas requiring activity or use limitations, minimizing unnecessary soil and habitat disturbance or destruction, utilizing native species to support habitat restoration or enhancements, and minimizing noise and lighting disturbance.

  - Weston agrees with the Army's current strategy that consideration of GSR practices will be incorporated throughout the entire project lifecycle or the complete remediation process from the initial assessment/investigation phase until project close-out. Specifically, Weston proposes to implement the following procedure and tasks under this project to minimize resource impacts and maximize sustainability:

    - Daily commuting of field crews to and from Fort Missoula will be by bulk transport (8 to 14 passenger vans).

    - Weston will provide individual refillable containers for worker hydration.

    - Weston will institute a waste minimization, segregation, and recycling program.

    - Weston will collect and recycle all scrap metal.

    - If needed on-site, Weston will utilize a mobile equipment trailer that is equipped with solar power for charging equipment and computers.

        - Weston's field teams will prevent the spread of noxious weeds by cleaning all ground equipment and washing all vehicle wheels prior to mobilizing to sensitive areas such as the BMRA. Equipment and vehicles would also be cleaned prior to demobilizing from these areas. All weed prevention activities will be in accordance with Montana Department of Agriculture and/or USFS guidance and best practices.

        - Storm water best management practices will be implemented at all MRS locations to minimize run-off potential.

        - Montana resources and local subcontractors will be utilized to the extent practicable to limit air travel.

        - Weston will provide WEBEX, teleconferencing, and video conferencing options to limit air travel for meetings.

- More specifics regarding some of these items, and examples of other GSR BMPs included in Appendix A already considered or incorporated by the Project Team, include (but are not limited to) the following:

    - Identifying stakeholder concerns regarding GSR issues through interviews and public meetings. The Project Team reported that the following stakeholder concerns had been identified:

        - Minimize disruption to public use of BMRA;

        - Provide safety information to the public;

        - Make use of social networking for improved communication;

        - Coordinate activities with the USFS;

        - Prevent spreading of invasive weeds;

        - Protect wildlife, sensitive species, rare plants; and

        - Identify and consider cultural artifacts.

    - Aligning schedules to minimize impacts to habitats or the public, such as:

        - Conducting work in early summer to reduce the fire risk ; and

        - Performing trail work on weekdays only, since trail use is heaviest on weekends.

    - Submitting reports electronically, including appendices and laboratory reports.

    - Including GSR in contract documents (it was stated during the Step 5 meeting that it is believed that this was the first Army MMRP project solicitation that included GSR requirements).

- Performing activities at the BMTA MRS sequentially with two other MRS projects, to avoid multiple mobilizations (reduces travel), and sharing resources with the USFS (such as for transport of explosives and trailhead security for BIP operation) which also reduces travel.

- Conducting a thorough review of historical documents (e.g., the HRR and SI) to significantly reduce the size of the area requiring investigation in the RI.

- Using a dynamic approach to determine optimal locations for intrusive operations based on information received from the DGM activities, information collected from excavating other metallic anomalies, and updated statistical evaluation.

- Using man-portable DGM applications versus vehicle-towed DGM to minimize disturbance to the habitat (e.g., less clearing) and to the public (e.g., less noise).

- Minimizing transportation of personnel (carpooling, teleconferences, use of subcontractors within driving distance, staying at same hotels, etc.).

- Minimizing transportation of equipment by consolidating soil samples for laboratory analysis into fewer coolers (which is possible due to long holding times) and purchasing equipment locally to avoid shipping (e.g., shovels).

- Recycling or re-using materials rather than disposing of them as waste:

    - Metal fragments that are certified to be explosive free will be sent to a recycling facility when feasible;

    - Unused sandbags will be beneficially re-used by MTARNG;

    - Unused explosives will be donated to the Sheriff's office for future beneficial use; and

    - Items such as barricades and sandwich boards will be donated to MTARNG or USFS after the project is completed so they can be beneficially re-used.

- Minimizing erosion and soil transport to surface water bodies:

    - Use low ground pressure ATVs to minimize soil disturbance when transport of demolition materials and supplies is needed;

    - Minimize extent of any excavations; and

    - Quickly re-seed any disturbed areas.

- Avoiding work in wetlands or any areas of historical or cultural sensitivity (to the extent possible) and photo-documenting any such areas (if any) prior to disturbing the area.

* While reviewing the BMP list at the Step 5 meeting, the GSR Team noted the extensive consideration of GSR principles by the Project Team, and no significant additional items regarding GSR were suggested by the GSR Team, other than the possibility of renting an existing

on-site office space if it was determined that an office trailer was necessary.

- For this pilot project, most of the BMPs determined to be “applicable” were also determined to be “practical”. One exception was the purchase of Renewable Energy Certificates (RECs) to offset footprints associated with project activities, which is not considered to be practical because it increases costs. RECs can be purchased on the open market to offset emissions due to project activities. Note that emissions related to this project are relatively low, since no heavy machinery is needed and emissions are primarily due to transportation.

- The previous application of numerous GSR BMPs by the Project Team is partly the result of incorporating GSR considerations throughout the planning process (a clear intent of the Project Team), which enhances the integration of GSR considerations throughout the remedial process. Many of the GSR considerations are consistent with approaches that would otherwise be selected to minimize cost or address public concerns, but highlighting GSR during project planning improves the likelihood that those considerations will be accounted for during project planning and execution.

2.2 QUANTITATIVE FOOTPRINT ANALYSIS FOR PLANNED RI/FS ACTIVITIES

2.2.1 Overview of Items Considered

Based on the discussions during the Step 5 meeting, this project is not expected to have a major footprint with respect to any quantitative GSR parameters. Heavy machinery use is not anticipated, and very few materials will be utilized. Two types of materials (explosives and sand bags) will be transported to the site for potential BIP activities, but it is assumed by the Project Team that they will not be used during the course of the field investigation and that they will subsequently be put to beneficial use for other projects, so only the transport of those materials is associated with a footprint for this project. Electricity use is not planned, and no significant use of water is planned (there is a contingency for use of water for fire suppression, but such use is not expected). Therefore, transportation of personnel and equipment is the only item expected to contribute in a tangible way to GSR footprints. This includes transportation of equipment and supplies, transportation of personnel for mobilization and while in town performing the work, and transportation for meetings associated with the project. Input to the SiteWise™ tool and other supporting calculations are described in Appendix B, which presents estimated quantities regarding transportation provided by the Project Team and any related assumptions made by the GSR Team for converting that information into input for SiteWise™.

2.2.2 Summary of Quantitative Footprint Results

Table 2-2 summarizes the quantitative footprint results for the planned RI/FS activities. Input to the SiteWise™ tool and other supporting calculations are described in Appendix B. The SiteWise™ files utilized for this portion of the analysis are supplied electronically (“Alternative 1”).

Table 2-2
Summary of Quantitative Footprint for Planned RI/FS Activities at BMTA

GSR Parameter	Unit	Value
Environmental		
Energy – Total	MMBtu	366.30
Energy – Direct Scope 1	MMBtu	1.39
Energy – Indirect Scope 2	MMBtu	0
Energy – Indirect Scope 3	MMBtu	364.91
% of Energy from Renewable Resources	%	0
Global warming potential – Total	Metric tons CO2e	31.88
Global warming potential – Direct Scope 1	Metric tons CO2e	0.08
Global warming potential – Indirect Scope 2	Metric tons CO2e	0
Global warming potential – Indirect Scope 3	Metric tons CO2e	31.80
Criteria air pollutant emissions	Metric tons (NOx+SOx+PM)	66
Hazardous air pollutant emissions	Lb	0
Potable water use	1,000s of gallons	negligible
Other water use	1,000s of gallons	negligible
Refined materials use	Lbs	negligible
% of refined materials from recycled material	%	N/A
Unrefined materials use	Ton	negligible
% of unrefined materials from recycled material	%	N/A
Non-hazardous waste generation	Ton	negligible
Hazardous waste generation	Ton	negligible
% of potential waste that is recycled or re-used	%	100%(1)
Land transferred or made available for beneficial use	Acres	0(2)
Existing ecosystem destruction	Acres	none assumed
Time frame for land re-use	Years	N/A(2)
Flexibility and breadth of options for re-use	see below	1
Economic		
Life-cycle Cost, Discounted	$	not provided
Life-cycle Cost, Undiscounted	$	not provided
Up-front Cost	$	not provided
Societal		
Predicted number of injuries or fatalities for On-Site Worker	Number of injuries or fatalities	0
Predicted number of injuries or fatalities associated with transportation	Number of injuries or fatalities	0.01
One-Way Heavy Vehicle Trips through Res. Area	Trips	0

**Scale for flexibility and breadth of re-use options (greater GSR value with lower number, indicating more breadth and flexibility for potential re-use)*

1 - Unlimited re-use options
2 - Limited re-use options
3 - Only one re-use option

(1) Any sand and explosives not used for BIP will be donated for re-use to avoid the need for disposal.

(2) Land use is currently not restricted (other than would be typical for land owned by USFS), and the RI/FS is not expected to impact future land use.

Table 2-2 divides total energy use and global warming potential into "direct" and "indirect" use and emissions. The following definitions are utilized for "direct" versus "indirect" energy use and global warming potential:

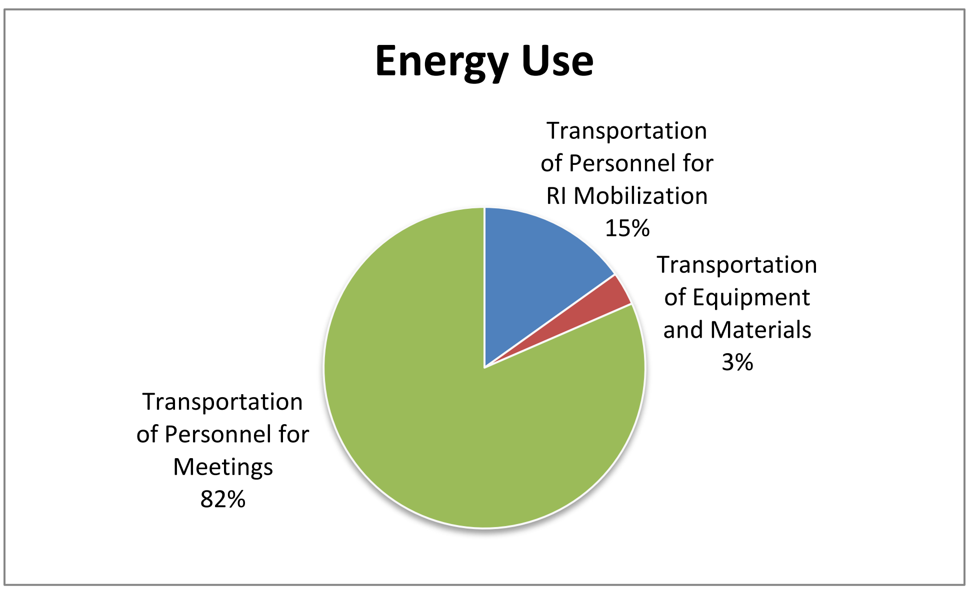
- Direct Scope 1: From sources that are owned or controlled by the reporting entity.
- Indirect Scope 2: Due to activities of the reporting entity, but occur at sources owned or controlled by another entity, from consumption of purchased electricity, heat or steam.
- Indirect Scope 3: Due to activities of the reporting entity, but occur at sources owned or controlled by another entity, other than Scope 2 (such as the extraction and production of purchased materials and fuels, transport-related activities in vehicles not owned or controlled by the reporting entity, outsourced activities, waste disposal, etc.

SiteWise™ reports total energy use and total global warming potential, but does not sum the "direct" and "indirect" components. The user needs to track the distinction between "direct" and "indirect" components separately, based on information contained within the SiteWise spreadsheets. The separation of the total energy and global warming potential is documented in Appendix B, which describes SiteWise™ input and related calculations.

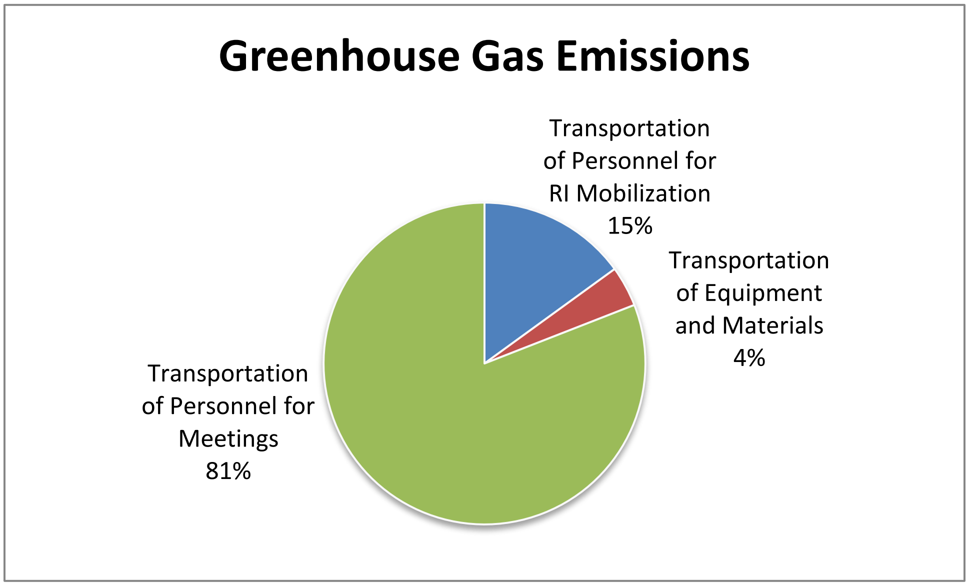
2.2.3 Key Findings from Quantitative Footprint Analysis, Consolidation and Capping

Observations and findings based on the quantitative footprinting results from SiteWise include the following:

- Energy use, which is entirely due to transportation, is very low. The primary contributors of the energy use are broken out below (based on percentage of total energy use):



- Greenhouse gas emissions, which are entirely due to transportation, are also very low. The primary contributors of the greenhouse gas emissions are broken out below (based on percentage of total CO2e):



- Nearly all of the energy use and greenhouse gas emissions are considered "Indirect Scope 3" because they relate to transportation to and from the site. The only component of energy use and greenhouse gas emissions considered to be "Direct Scope 1" is associated with the on-site use of ATVs, and this contributes less than 1% of the total energy use and greenhouse gas emissions.

- Estimated footprints for NOx, SOx, and PM are also due to transportation, and are also low for this project.

- There is no significant electricity use associated with this project. Thus, it is assumed that 0% of the energy comes from renewables, though biodiesel may be used for fuel in some cases.

- There is no significant materials usage or waste disposal.

- The RI/FS is not expected to impact future land use.

- The total number of injuries/fatalities calculated by SiteWise™ is low (approximately 0.01 over the course of the project), and the calculated risk is entirely from transportation (100%) since there is no heavy equipment use planned.

Overall, this RI/FS project has an extremely low environmental footprint based on the GSR parameters considered in this Study. This result is partly due to the fact that this project is a one-time activity (as opposed to annual O&M for a long-term groundwater remedy, for instance), and also due to the fact that so few materials are needed, negligible waste will be generated, and no heavy equipment use is envisioned.

2.3 OTHER QUALITATIVE CONSIDERATIONS

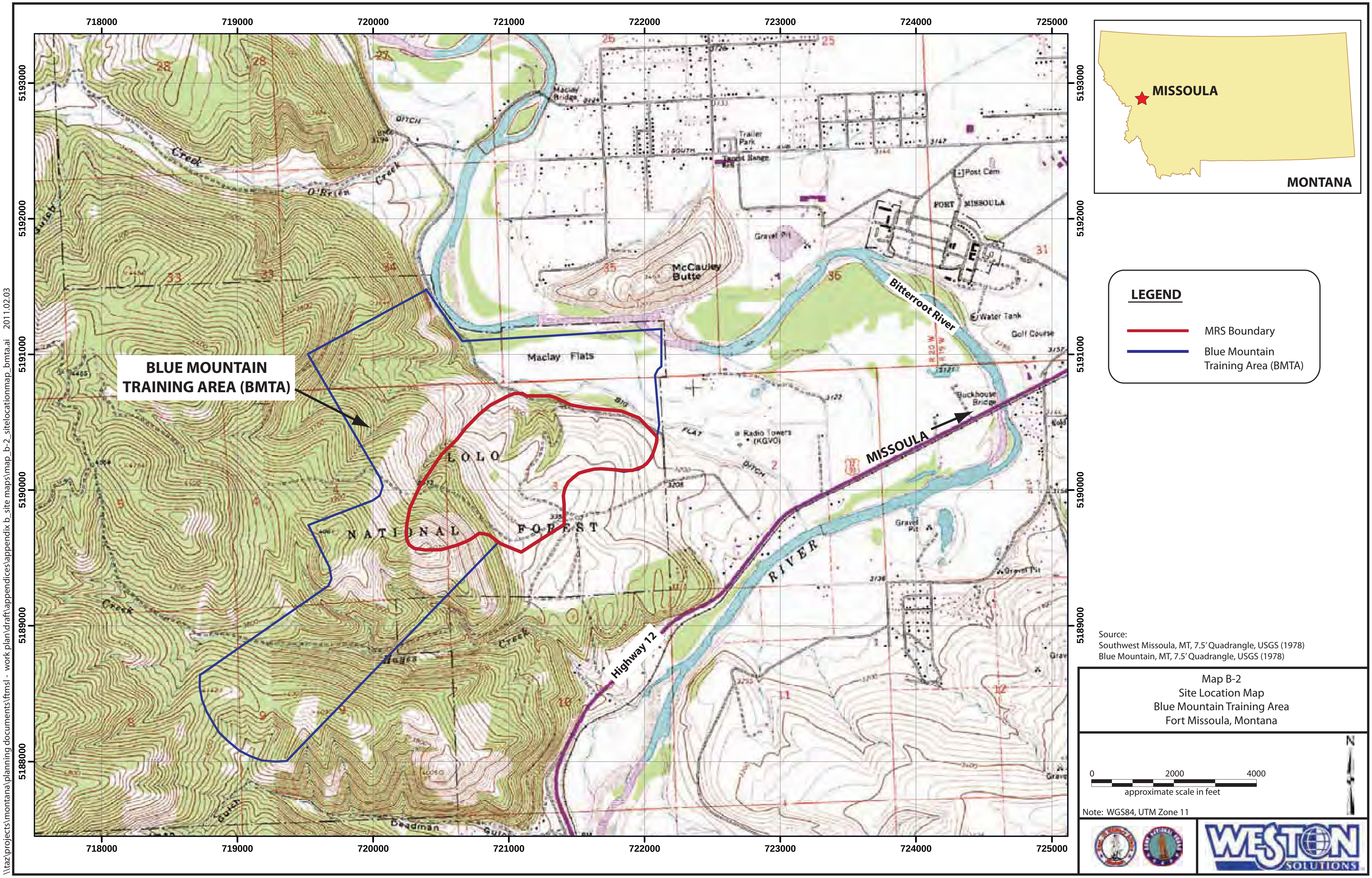
It is common for GSR evaluations to compare footprint reductions that might result from alternative actions to those currently planned. However, for this pilot project, there does not appear to be a rationale for evaluating such comparisons. The quantitative GSR footprints calculated for the planned RI/FS activities are extremely low (due only to transportation), so no significant reductions in GSR footprints are needed. Also, RI/FS activities (such as the trail work, DGM, intrusive investigation, and MC sampling) have been planned with GSR considerations already taken into account (such as to minimize disturbance to habitat and/or the public), such that the planned RI/FS activities appear to represent the preferred approach for conducting the RI/FS.

3.0 GSR RECOMMENDATIONS

As discussed in Section 2.3, the GSR Team offers no recommendations based on consideration of BMPs or quantitative footprinting. The quantitative GSR footprints calculated for the planned RI/FS activities are extremely low (due only to transportation), so no significant reductions in GSR footprints are needed. Also, RI/FS activities (such as the trail work, DGM, intrusive investigation, and MC sampling) have been planned with GSR considerations already taken into account (such as to minimize disturbance to habitat and/or the public), such that the planned RI/FS activities appear to represent the preferred approach for conducting the RI/FS.

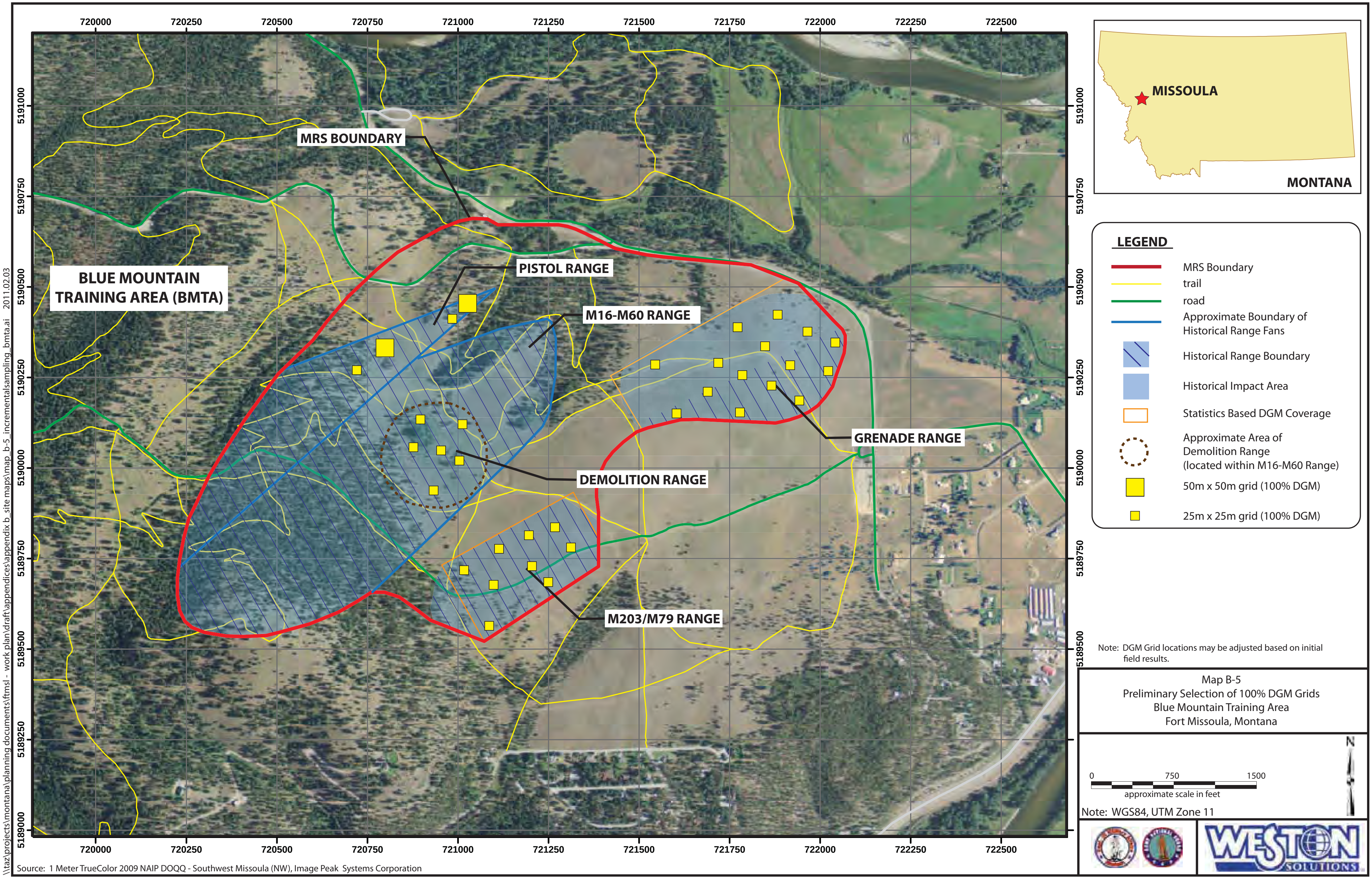
FIGURES

Figure 1-1. Location of Blue Mountain Training Area (BMTA) MRS Boundary



From Map B-2 of Draft RI/FS Work Plan by Weston Solutions (February, 2011)

Figure 1-2. Former Ranges and Preliminary Digital Geophysical Mapping (DGM) Grids



From Map B-5 of Draft RI/FS Work Plan by Weston Solutions (February, 2011)

APPENDIX A

Best Management Practice (BMP) Tables

BMP Category A: Planning

<table>
<tr><td colspan="3">BMP A-1: Develop a culture of GSR within the Project Team and encourage GSR ideas from project staff</td><td>Date: 12/21/11
☒ Applicable
☒ Evaluated
☒ Practical</td></tr>
<tr><td>Implemented?
("N/A" if "Practical" not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☒ Economic ☒Social</td><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="2">Resources Conserved:
☒ Hazardous air pollutants ☒ Energy ☒ Waste
☒ Criteria pollutants ☒ Materials ☒ Safety/Community
☒ GHG emissions (CO2e) ☒ Water ☒ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

GSR is a part of Weston's corporate culture. For example, there is a sustainability message on Weston business cards. At MTARNG, Sundi West's email signature also includes a sustainability message.</td></tr>
</table>

<table>
<tr><td colspan="3">BMP A-2: Incorporate a section on GSR in project meetings, work plans, and reports</td><td>Date: 12/21/11
☒ Applicable
☒ Evaluated
☒ Practical</td></tr>
<tr><td>Implemented?
("N/A" if "Practical" not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☒ Economic ☒ Social</td><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="2">Resources Conserved:
☒ Hazardous air pollutants ☒ Energy ☒ Waste
☒ Criteria pollutants ☒ Materials ☒ Safety/Community
☒ GHG emissions (CO2e) ☒ Water ☒ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

A section on GSR is included in presentations, the RI/FS work plan, and is planned for the RI report. GSR considerations are also an agenda item for each project call. A page called "Sustainability Commitment" is included on the project website that is available to the public.</td></tr>
</table>

BMP Category A: Planning

<table>
<tr><td colspan="2">BMP A-3: Identify and periodically update a list of key stakeholders and their concerns with respect to GSR considerations</td><td>Date: 12/21/11
☒ Applicable
☒ Evaluated
☒ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A</td><td colspan="2">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☐ Economic ☒ Social</td><td colspan="2">Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td>Resources Conserved:
☒ Hazardous air pollutants ☒ Energy ☒ Waste
☒ Criteria pollutants ☒ Materials ☒ Safety/Community
☒ GHG emissions (CO2e) ☒ Water ☒ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Notes (including discussion of possible value of implementing the BMP):

Matrix, a member of the Project Team subcontracted to Weston, interviewed 10 to 20 people from various community and recreation groups. The Project Team met with the Missoula County Commissioners on May 12, 2011. The forest service is also a stakeholder and actively participates in project planning and coordination. Several public meetings have been held. Key stakeholder issues that have been identified include the following:
• Minimize disruption to public use of Blue Mountain
• Provide safety information to the public
• Make use of social networking for improved communication
• Coordinate activities with the USFS
• Prevent spreading of invasive weeds
• Protect wildlife, sensitive species, rare plants
• Identify and consider cultural artifacts</td></tr>
</table>

<table>
<tr><td colspan="2">BMP A-4: Schedule activities for appropriate seasons and/or time of day to reduce delays caused by weather conditions and fuel needed for heating or cooling
Examples:
- Work at night in summer to avoid heat stress
- Perform field activities in summer to take advantage of longer daylight</td><td>Date: 12/21/11
☒ Applicable
☒ Evaluated
☒ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A</td><td colspan="2">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☐ Economic ☒ Social</td><td colspan="2">Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td>Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☒ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Notes (including discussion of possible value of implementing the BMP):

The Project Team has had an extensive discussion with the forest service regarding the potential for fire (from BIP operations, if needed) and disturbance to trail use. They will need to conduct work in early summer to reduce the fire risk (since there is a heightened fire risk from mid-July to the end of August). Work is also not started too early in the spring, since the ground is typically too wet (or sometimes frozen, making digging more difficult). Trail use is heaviest on weekends, so field work will not be conducted on weekends. Nesting seasons have been considered.</td></tr>
</table>

BMP A-5: Prepare, store, and distribute documents electronically	**Date:** 12/21/11 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < \$10,000 ☐ \$10,001 - \$50,000 ☐ \$50,001 - \$100,000 ☐ \$100,001 - \$500,000 ☐ > \$500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☐ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Hard copies are already being minimized. Lab reports and appendices are included on disk, and reviews of reports are done via "redlined" electronic copies. ESP and DDESB submissions have been electronic.*	

BMP A-6: Utilize teleconferences rather than meetings when feasible	**Date:** 12/21/11 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < \$10,000 ☐ \$10,001 - \$50,000 ☐ \$50,001 - \$100,000 ☐ \$100,001 - \$500,000 ☐ > \$500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP is already being implemented using WEBEX, which minimizes the number of meetings conducted in person.*	

BMP A-7: Incorporate green specifications into solicitations and contracts Examples: - Follow pertinent green procurement policies - Select hotel chains with "green" policies - Select laboratories that utilize renewable energy	**Date:** 12/21/11 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☒ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

It was stated during the Step5 meeting that it is believed that this was the first MMRP project bid with GSR requirements. Weston includes awareness of GSR considerations in subcontract agreements.

BMP A-8: Integrate schedules to allow for resource sharing and fewer days of field mobilization	**Date:** 12/21/11 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☐ Waste ☒ Criteria pollutants ☐ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

The MMRP projects at Fort Missoula (BMTA is one of the three) are planned to be implemented sequentially to minimize travel for mobilization and demobilization.

The project will be sharing resources with the sheriff's office for explosives required for a BIP event. The project will also share resources with the forest service for closing off trails during BIPs. This resource sharing minimizes the need for extra field personnel.

BMP Category A: Planning

BMP A-9: Explore multiple site re-use options, including those that include some restriction of site re-use and related resource conservation	**Date:** 12/21/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☒ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

This BMP is not applicable for this project, since land use is already unrestricted.

BMP A-10: Conduct thorough review of project documents and historical records to minimize required scope of investigation Examples: - IRP projects: determine if there are previous aquifer tests that can be used for groundwater modeling rather than conducting new aquifer tests - MMRP projects: perform careful review of historic documents, aerial photographs, and other existing information to reduce the footprint of land that needs to be disturbed for thorough investigation and remediation - MMRP projects: use IRP sampling data to supplement and enhance the MMRP field program (if available)	**Date:** 12/21/11 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Thorough review during the HRR and SI narrowed the size of the area to be evaluated during the RI. Also, the public outreach also brought in historical information that helped narrow the area that needs to be addressed during the RI. The senior geologist on the Project Team was involved in the SI and brings that institutional knowledge to the RI/FS team. The forest service has extensive knowledge of the local area. In addition, the Project Team has institutional knowledge of weapons systems, so they know the probable weapons ranges and likely patterns of debris.

BMP Category B: Characterization and/or Remedy Approach

BMP B-1: Develop and routinely update a conceptual site model (CSM) to use as a basis for making remedial process decisions	**Date:** 12/21/11 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☒ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *The CMS is described in the work plan, and is a key to the MMRP process. Risk analysis will be conducted throughout the RI as more information is developed and the conceptual model is updated.*	

BMP B-2: Perform frequent optimization evaluations to improve efficiency of current or planned actions and/or develop alternative remedial approaches that might shorten remedy duration or otherwise improve the net environmental benefit of the remedy	**Date:** 12/21/11 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☒ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *An example is the dynamic nature of the decisions that will be made for digging anomalies detected on the DGM grids. Not all anomalies will be dug – optimal locations for digging will be determined based on information received from the DGM activities, information collected from digging other anomalies, and updated statistical evaluation. The amount of up-front investment in using this dynamic approach is hard to quantify, but it very likely leads to cost reduction and less disruption to the recreation area overall because it avoids digging all anomalies.*	

BMP Category B: Characterization and/or Remedy Approach

<table>
<tr><td colspan="3">BMP B-3: Use appropriate characterization or remedy approach based on site conditions
Examples:
- Consider in-situ and passive remedy options that offer adequate protectiveness
- Consider in-situ bioremediation if conditions are already anaerobic and constituents are conducive to reductive dechlorination
- Compare source removal versus in-situ and ex-situ remedial options
- Consider different technologies for impacted areas with higher and lower concentrations
- Use realistic times to remedy closeout (i.e., estimations through modeling) rather than assumed remedy timeframes (e.g., 30 years), which is often used for evaluation of FS alternatives
- MMRP projects: evaluate man-portable DGM instruments versus vehicle-towed array (VTA) instruments and inclusion of detector-aided reconnaissance (DAR)</td><td>Date: 12/21/11

☒ Applicable
☒ Evaluated
☒ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
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<tr><td colspan="2">Resources Conserved:
☐ Hazardous air pollutants ☒ Energy ☐ Waste
☒ Criteria pollutants ☐ Materials ☒ Safety/Community
☒ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

Man-portable DGM will be used rather than vehicle-towed array to prevent destruction of the forest and avoid noise impacts. The decision to take discrete samples or use ISM will be based on the signal of the anomaly and the size of the area.</td></tr>
</table>

<table>
<tr><td colspan="3">BMP B-4: Establish decision points to trigger a change from one technology to another or from one remedy alternative to another
Examples:
- Change vapor treatment from thermal oxidation to granular activated carbon (GAC) media based on flow rates and concentrations
- Remove a treatment polishing step if influent to that step already meets discharge criteria
- Move to Monitored Natural Attenuation (MNA) if specific concentration thresholds in groundwater are met</td><td>Date: 12/21/11

☒ Applicable
☒ Evaluated
☒ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
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<tr><td colspan="2">Resources Conserved:
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☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

A decision tree will be used to determine whether to use discrete sampling or ISM, BIP or consolidation, EM or MAG, and to compare other alternate methods.</td></tr>
</table>

BMP Category B: Characterization and/or Remedy Approach

<table>
<tr><td colspan="2">BMP B-5: Focus sampling efforts to meet objectives of the specific remedial phase (e.g., sampling during O&M should be focused on evaluating remedy performance and not on thorough plume characterization)
Examples:
- Eliminate sampling parameters as appropriate
- Reduce sampling frequency as appropriate
- Reduce sample locations as appropriate
- Enhance monitoring program as appropriate
- MMRP projects: consider Incremental Sampling Methodology (ISM) versus discrete sampling for MC characterization</td><td>Date: 12/21/11

☒ Applicable
☒ Evaluated
☒ Practical</td></tr>
<tr><td>Implemented?
("N/A" if "Practical" not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A</td><td colspan="2">Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
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<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
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☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Notes (including discussion of possible value of implementing the BMP):

If no soil impacts are discovered, groundwater will not be sampled. In addition, the appropriateness of discrete sampling or ISM will be determined based on conditions.</td></tr>
</table>

BMP Category B: Characterization and/or Remedy Approach

<table>
<tr><td colspan="3">BMP B-6: Consider real-time measurements and dynamic work plans to reduce mobilizations and improve effectiveness of investigation efforts
Examples:
- Field test kits (e.g., test kits for sulfate)
- Field screening instruments (e.g., x-ray fluorescence for lead or photoionization detectors for volatile organics)
- Drive point sensor technologies (e.g., membrane interface probe or “MIP”)
- Visual staining or odor
- Establish excavation extent based on real-time data collected as excavation proceeds and use GPS to accurately delineate excavation areas
- MMRP projects: use GPS and/or the same equipment that was used for detection to confirm anomaly signatures prior to excavating
- MMRP projects: consider incorporating field screening methods (e.g., X-ray fluorescence, EXPRAY and explosives test kits, as appropriate or applicable) into the field program to refine sampling locations and reduce the quantities of samples submitted for off-site laboratory analysis</td><td>Date: 12/21/11

☒ Applicable
☒ Evaluated
☒ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
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<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
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If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

An example is the use of GPS when anomalies are detected so they can be re-acquired if digging is desired. Other examples are provided for other BMPs.</td></tr>
</table>

BMP Category B: Characterization and/or Remedy Approach

BMP B-7: Consider use of existing site structures/infrastructure or mobilization of temporary structures versus new construction Examples: - Buildings (e.g., for treatment building or field office) - Concrete slabs or foundations - Wells - Existing excavations for storm water control	**Date:** 12/21/11 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *No off-site trailer or office is planned, just a storage trailer, which will have the sandbags as close to the site as possible for BIP if needed.* *They will be using the sheriff's trucks and magazine for explosives, avoiding the need for additional equipment.* *Will be using port-a-johns that are already part of the BMRA infrastructure.*	

BMP B-8: Establish project-specific decision points to limit extent of remediation Examples: - Project-specific cleanup levels based on a site-specific risk assessment (coordinated with risk assessment experts) rather than generic cleanup levels, if it results in lower footprints for key parameters and is acceptable to all stakeholders - MMRP projects: dig stopping rules and anomaly prioritization/detection criteria to minimize false positives	**Date:** 12/21/11 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *They will not be digging every anomaly; instead, review of GIS distribution and the use of a decision framework will help to determine where to dig. In addition, the DQO process will help to limit false positives.*	

BMP Category B: Characterization and/or Remedy Approach

<table>
<tr><td colspan="3">BMP B-9: Consider leaving in place structures whose removal is not necessary (i.e., foundations, underground pillars, etc.)</td><td>Date: 12/21/11
☐ Applicable
☐ Evaluated
☐ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
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<tr><td colspan="2">Resources Conserved:
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If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

This BMP is not applicable for this project, since no structures will be removed.</td></tr>
</table>

BMP Category C: Energy/Emissions – Transportation

BMP C-1: Reduce the number of trips for personnel
Examples:

- Encourage carpooling
- Use telemetry systems and webcams to remotely transmit data directly to project offices to avoid trips

Date: 12/21/11

☒ Applicable

☒ Evaluated

☒ Practical

Implemented?
("N/A" if "Practical" not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☒ Economic ☒ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☐ Hazardous air pollutants ☒ Energy ☐ Waste
☒ Criteria pollutants ☐ Materials ☒ Safety/Community
☒ GHG emissions (CO2e) ☐ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

The work plan calls for carpooling to and from Fort Missoula in 8 to 14 passenger vans. Will use hotel shuttle when possible.

The three MRSs (one of which is BMTA) will be addressed sequentially to reduce mobilization and demobilization.

DGM data is transmitted electronically.

BMP C-2: Reduce the number of trips and/or volume for transported materials, equipment, or waste
Examples:

- Transfer full loads by consolidating shipments from vendors and/or shipments to disposal sites (also share shipments with neighbors if feasible)
- Purchase more concentrated chemicals to reduce transportation weight and/or volume

Date: 12/21/11

☒ Applicable

☒ Evaluated

☒ Practical

Implemented?
("N/A" if "Practical" not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☒ Economic ☒ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☐ Hazardous air pollutants ☒ Energy ☐ Waste
☒ Criteria pollutants ☐ Materials ☒ Safety/Community
☒ GHG emissions (CO2e) ☐ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Items required for BIP (if needed) such as sand bags and explosives will be stored nearby.

Number of lab shipments will be reduced by consolidating into fewer coolers, which is possible due to long holding times.

Purchasing equipment (e.g., shovels) locally so they don't need to be shipped.

BMP Category C: Energy/Emissions – Transportation

BMP C-3: Reduce trip lengths Examples: - Dispose of waste at closest appropriate facility - Purchase materials, equipment, and services from local vendors - Use locally produced supplies - Select most efficient transportation route	**Date:** 12/21/11 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☒ Energy ☐ Waste ☒ Criteria pollutants ☐ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Using local staff and subcontractors whenever possible (that are within driving distance).*	

BMP C-4: Use alternate fuels or other options for transportation when possible Examples: - Compressed natural gas - Biodiesel blends - Ethanol blends - Hybrid and/or electric - Rail lines versus trucks - Use a fuel efficient passenger car rather than a pickup truck if task allows	**Date:** 12/21/11 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☒ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☒ Energy ☐ Waste ☒ Criteria pollutants ☐ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Plan to use most efficient vehicle appropriate for each task.* *Biodiesel will be used for the ATVs, if available.*	

BMP Category D: Energy/Emissions – Equipment Use

BMP D-1: Consider and implement approaches to minimize engine idle times

Date: 12/21/11

☐ Applicable
☐ Evaluated
☐ Practical

Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☒ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Not really applicable because no heavy equipment use is planned. It was noted that idling of vehicles for personnel transport will be discussed during safety briefings.

BMP D-2: Ensure peak operating efficiency of equipment to reduce energy use and emissions
Examples:

- Perform preventative maintenance and operate equipment per manufacturer instructions
- Perform retrofits involving low-maintenance multi-stage filters for cleaner engine exhaust
- Use synthetic oil to extend operating life (and reduce waste oil)
- Purchase newer equipment with reduced emissions

Date: 12/21/11

☐ Applicable
☐ Evaluated
☐ Practical

Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☒ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Not really applicable because no heavy equipment use is planned.

BMP Category D: Energy/Emissions – Equipment Use

BMP D-3: Use alternate fuel options for equipment when possible Examples: - Compressed natural gas - Biodiesel - Ethanol blends - Ultra-low sulfur diesel, wherever available (and as required by engines with PM traps)	**Date:** 12/21/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☒ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < \$10,000 ☐ \$10,001 - \$50,000 ☐ \$50,001 - \$100,000 ☐ \$100,001 - \$500,000 ☐ > \$500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Not really applicable because no heavy equipment use is planned.

BMP D-4: Select appropriate equipment and/or power source for the job Examples: - Avoid using large excavators for small earthmoving projects - Use direct push methods when possible to reduce drilling duration - Compare potential use of electricity versus battery versus generator	**Date:** 12/21/11 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < \$10,000 ☐ \$10,001 - \$50,000 ☐ \$50,001 - \$100,000 ☐ \$100,001 - \$500,000 ☐ > \$500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Using hand tools for vegetation clearing (which is expected to be minimal).

BMP Category D: Energy/Emissions – Equipment Use

BMP D-5: Use variable frequency drives on motors (e.g., pumps, blowers), or replace oversized motors with properly sized motors	**Date:** 12/21/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☒ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

This BMP is not applicable for this project, since no pumps, blowers, or similar equipment will be used.

BMP D-6: Identify options for generating renewable energy for direct use in the remedy and/or for alternate use at or near the project site Examples: - Solar, wind, landfill gas (microturbines), combined heat and power, geothermal heat exchange - Applications for remote areas such as solar pumps or solar flares (if demand is not continuous, the need for a battery backup may be avoided) - Generate power or heat exchange from water to be discharged	**Date:** 12/21/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☒ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Very little energy will be used for this project, so this is not really applicable. It was noted that cell phones will be recharged with solar power.

BMP Category D: Energy/Emissions – Equipment Use

<table>
<tr><td colspan="3">BMP D-7: Consider purchase of renewable energy certificates to offset emissions from the remedial activities</td><td>Date: 12/21/11
☒ Applicable
☒ Evaluated
☐ Practical</td></tr>
<tr><td>Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☒ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social</td><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="2">Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

This is not likely to be considered practical for this project. This would cause a cost increase, and such decisions would be Installation-specific and are not planned here. This would cause a cost increase and an up-front cost, but the cost cannot be specifically determined. It is noted that the planned RI activities use very little energy since there is so little use of equipment, and operations are for a relatively short duration.</td></tr>
</table>

<table>
<tr><td colspan="3">BMP D-8: Design/modify housing required for above-ground treatment components for energy-efficiency
Examples:
- Passive lighting
- Compact fluorescent lighting (CFL) or light-emitting diode (LD) lighting
- Timers and/or motion control sensors for lighting
- Shading
- Minimize heating and cooling needs (building size, insulation, etc.)</td><td>Date: 12/21/11
☐ Applicable
☐ Evaluated
☐ Practical</td></tr>
<tr><td>Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☒ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social</td><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="2">Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

This BMP is not applicable for this remedy, since there is no above-ground treatment component.</td></tr>
</table>

BMP Category D: Energy/Emissions – Equipment Use

<table>
<tr><td colspan="2">BMP D-9: For remedies that involve groundwater or air extraction, optimize extraction to reduce flow rates (potentially beneficial with respect to energy use, materials usage, water resources, waste disposal, etc.)</td><td>Date: 12/21/11
☐ Applicable
☐ Evaluated
☐ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A</td><td colspan="2">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☒ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social</td><td colspan="2">Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td>Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Notes (including discussion of possible value of implementing the BMP):

This BMP is not applicable for this project.</td></tr>
</table>

<table>
<tr><td colspan="2">BMP D-10: Consider pulsing for extraction of water or air to maximize mass removal per unit of time or energy, by extracting higher concentrations</td><td>Date: 12/21/11
☐ Applicable
☐ Evaluated
☐ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A</td><td colspan="2">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☒ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social</td><td colspan="2">Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td>Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Notes (including discussion of possible value of implementing the BMP):

This BMP is not applicable for this project.</td></tr>
</table>

BMP Category D: Energy/Emissions – Equipment Use

BMP D-11: Run electrical equipment during times of lower electric demand if possible (this does not reduce energy use but could lower cost and also can lower stress on the energy grid during periods of peak demand)	**Date:** 12/21/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☒ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

This BMP is not applicable for this project.

BMP Category E: Materials & Off-Site Services

BMP E-1: Use materials that are made from recycled materials Examples: - Steel - Asphalt - Plastics - Concrete	**Date:** 12/21/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☒ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Very few materials will be used for this project, so this is not really applicable.*	

BMP E-2: Optimize the amount of materials used Examples: - Experiment with different material amounts/doses - Consider alternate materials - Use timers or feedback loops and process controls for dosing - MMRP projects: minimize quantities of donor explosives for MEC destruction	**Date:** 12/21/11 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☒ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *It was stated that the Project Team will print as few color maps as needed, limiting use of paper and ink. For BIP, the minimum amount of explosives that are needed will be used. Again, very few materials will be used for this project.*	

BMP Category E: Materials & Off-Site Services

BMP E-3: Utilize less refined materials when feasible Examples: - Limestone instead of sodium hydroxide for pH adjustment - Native fill instead of select fill	**Date:** 12/21/11 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☒ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

The Project Team indicated they may purchase sand for BIP sandbags from a local quarry rather than refined sand from a place like Home Depot, which is potentially less refined (doesn't reduce materials use, but does potentially reduce refined materials use). Note this is a small amount of sand that is planned for these activities.

BMP E-4: Identify opportunities for using by-products or "waste" materials from local sources in place of refined chemicals or materials Examples: - Cheese whey, molasses, compost, or off-spec food products for inducing anaerobic conditions - Crushed concrete for use as fill - Concrete from coal combustion byproducts	**Date:** 12/21/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☒ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Does not apply to this project, very little materials use is planned.

BMP Category E: Materials & Off-Site Services

<table>
<tr><td colspan="3">BMP E-5: Reduce demand on Publicly Owned Treatment Works (POTWs)
Examples:
- Discharge treated water to groundwater or to surface water rather than POTW
- Minimize amount of water requiring treatment</td><td>Date: 12/21/11
☐ Applicable
☐ Evaluated
☐ Practical</td></tr>
<tr><td>Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☒ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social</td><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="2">Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

This BMP is not applicable for this project, since purge water is disposed of off-site as investigation-derived waste.</td></tr>
</table>

BMP Category F: Water Resource Use

BMP F-1: Minimize water consumption Examples: - Sensors to turn off water when not needed - Low flow fittings - Minimize water needs for irrigation (landscape choices, use of mats and mulch)	**Date:** 12/21/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☒ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Not really applicable since so little water use is planned. Refillable containers will be used for drinking water, but that is for waste reduction rather than minimizing consumption. Other water use is for fire suppression and steam cleaning.*	

BMP F-2: Preferentially use less refined water resources when feasible Examples: - Use extracted groundwater instead of potable water for chemical blending - Capture and store rain/storm water for future use - Employ rumble grates with a closed-loop gray-water washing system	**Date:** 12/21/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☒ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Not really applicable since so little water use is planned. It was stated that fire trucks can use non-potable water, but it is not clear that any such use will be required.*	

BMP Category F: Water Resource Use

<table>
<tr><td colspan="2">BMP F-3: Use extracted and treated water for beneficial purposes
Examples:
- Irrigation
- Potable water
- Industrial process water</td><td>Date: 12/21/11
☐ Applicable
☐ Evaluated
☐ Practical</td></tr>
<tr><td>Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A</td><td colspan="2">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☒ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
Environmental ☐ Economic ☐ Social</td><td colspan="2">Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td>Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Notes (including discussion of possible value of implementing the BMP):

No water extraction is associated with this project.</td></tr>
</table>

<table>
<tr><td colspan="2">BMP F-4: Promote groundwater recharge
Examples:
- Recharge extracted and treated water when beneficial uses of the water are not identified and reinjection is practical
- Minimize site area covered by impervious surfaces to reduce runoff and maximize infiltration (unless such capping is a specific component of the remedial action)</td><td>Date: 12/21/11
☐ Applicable
☐ Evaluated
☐ Practical</td></tr>
<tr><td>Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A</td><td colspan="2">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☒ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social</td><td colspan="2">Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td>Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Notes (including discussion of possible value of implementing the BMP):

Does not apply to this project.</td></tr>
</table>

BMP Category F: Water Resource Use

BMP F-5: Maintain water quality by preventing nutrient loading to surface water or groundwater Examples: - Use phosphate-free detergents instead of organic solvents or acids to decontaminate sampling equipment (if not required for some contaminants)	**Date:** 12/21/11 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☒ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Plan to use environmentally friendly "simple green", which will not damage any water resources.

BMP Category G: Waste Generation, Disposal, and Recycling

BMP G-1: Minimize drill cuttings and all other investigation derived waste (including personal protection equipment) Examples: - Direct push or sonic drilling to reduce drill cuttings - Low-flow sampling or passive diffusion bags (if applicable) to reduce purge water - When possible place drill cuttings on-site rather than off-site disposal	**Date:** 12/21/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☒ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Not really applicable since there will be very little investigation derived waste or PPE. There is no groundwater sampling, so there will be no purge water. Water from steam cleaning will be discharged to groundwater with supervision by USFS.*	

BMP G-2: Segregate excavated soil in pre-planned staging areas so that "clean" material can be deposited on-site and/or re-used rather than transported for off-site disposal	**Date:** 12/21/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☒ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *There is no significant waste expected from this project that will require off-site disposal.*	

BMP Category G: Waste Generation, Disposal, and Recycling

BMP G-3: Consider on-site treatment and re-use of soil instead of off-site disposal Examples: - Land farming - Above ground soil vapor extraction (SVE)	**Date:** 12/21/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☒ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Not applicable to this phase of the remedy.*	

BMP G-4: Minimize need to transport and dispose hazardous waste Examples: - Consider delisting listed hazardous waste if waste is not characteristically hazardous waste - Segregate hazardous waste and non-hazardous waste	**Date:** 12/21/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☒ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *No hazardous waste is expected.*	

BMP Category G: Waste Generation, Disposal, and Recycling

BMP G-5: When possible avoid/minimize use of hazardous/toxic materials that may require special handling or disposal Examples: - Cleaning solutions - Pesticides - Disposable batteries (use rechargeable batteries) - MMRP projects: minimize Chemical Agent Contaminated Media (CACM) at RCWM sites.	**Date:** 12/21/11 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☒ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Plan to use rechargeable batteries that do not require disposal.*	

BMP G-6: Recycle or re-use materials rather than disposing of them Examples: - Cardboard - Plastics - Concrete - Asphalt - Steel and other metals - Recovered oil/product - Mulch/compost - MMRP projects - recycle recovered Material Documented as Safe (MDAS) after inspection and certification that the remnants are free of explosive hazards	**Date:** 12/21/11 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☒ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Metal fragments will be sent to a recycling facility when feasible. The Project Team indicated that any unused sandbags will be beneficially re-used by MTARNG, and any unused explosives will be donated to the Sheriff's office for future beneficial use (i.e., they will not be wasted if not used during the RI). Similarly, items such as barricades and sandwich boards will be donated to MTARNG or USFS after the project is completed so they can be beneficially re-used.*	

BMP Category H: Land Use, Ecosystems, and Cultural Resources

BMP H-1: Minimize erosion and soil transport to surface water bodies
Examples:
- Quickly restore any vegetated areas disrupted by equipment or vehicles
- Institute appropriate erosion controls during excavation such as silt fencing

Date: 12/21/11
☒ Applicable
☒ Evaluated
☒ Practical

Implemented?
("N/A" if "Practical" not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☒ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Plan to use low ground pressure ATVs when transport is needed (such as transporting sandbags for BIP) to minimize soil disturbance.

Project Team will try to minimize extent of any excavations.

Project Team plans to quickly re-seed any disturbed areas.

BMP H-2: Minimize disturbances to land
Examples:
- Establish well-defined traffic patterns for onsite activities to minimize disturbed areas
- Consider non-intrusive investigation techniques (e.g., geophysical methods) to identify items like USTs and buried drums

Date: 12/21/11
☒ Applicable
☒ Evaluated
☒ Practical

Implemented?
("N/A" if "Practical" not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☒ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☒ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Work will stay on or near trails to extent possible. Any damage to trails will be quickly restored. Off-road work to be coordinated with USFS to minimize disturbances to land. Decision framework for digging anomalies should minimize amount of digging required, which minimizes disturbance but also saves money.

BMP Category H: Land Use, Ecosystems, and Cultural Resources

BMP H-3: Preserve/restore ecosystems to the extent possible Examples: - Limit the removal of trees and vegetation - Attempt to transplant disturbed shrubs and small trees to other locations - Use native species for re-vegetation - Retrieve dead trees during excavation and later reposition them as habitat snags - Select and place suitably sized and typed stones into water beds and banks - Undercut surface water banks in ways that mirror natural conditions - Cut back rather than remove trees, bushes, vegetation	**Date:** 12/21/11 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☒ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Very little clearing is anticipated to be needed for this work. Work in wetlands areas is being avoided. Native species will be used for re-vegetation, to be provided by the USFS.*	

BMP H-4: Minimize drawdown of the water table in sensitive areas such as wetlands or areas subject to subsidence	**Date:** 12/21/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☒ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP is not applicable for this project, since no GW extraction will likely take place.*	

BMP Category H: Land Use, Ecosystems, and Cultural Resources

BMP H-5: Construct wells and other remedial process infrastructure (piping, buildings, etc.) to minimize restrictions to anticipated future use of the site	**Date:** 12/21/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☒ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP is not applicable for this project.*	

BMP H-6: Preserve/restore cultural resources to the extent possible Examples: - Protected lands such as wildlife refuges, national parks, and wilderness areas - Culturally sensitive sites such as cemeteries, native burials, and archaeological finds - Buildings or land parcels with historical significance	**Date:** 12/21/11 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This was raised by the public as a concern. There are some potential cultural resource areas that have been identified, and efforts will be made to avoid disturbances. This will be discussed at tailgate briefings.*	

BMP Category H: Land Use, Ecosystems, and Cultural Resources

<table>
<tr><td colspan="3">BMP H-7: Document sensitive ecological and cultural resources prior to initiating actions that might diminish or destroy those resources
Examples:
- Photodocument conditions prior to clearing brush
- MMRP projects: photodocument conditions prior to BIP</td><td>Date: 12/21/11
☒ Applicable
☒ Evaluated
☒ Practical</td></tr>
<tr><td>Implemented?
("N/A" if "Practical" not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☐ Economic ☐ Social</td><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="2">Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

Any potential cultural resources identified (e.g., during digging) will be photographed. If BIP is needed, areas will be photographed before and after to document conditions.</td></tr>
</table>

BMP Category I: Safety and Community

BMP I-1: Minimize and mitigate noise, light and odor disturbance during all phases of the remedial process, to the extent practicable	**Date:** 12/21/11 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☒ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

During BIP (if needed) sandbags will mitigate noise (as well as fragments). There are also BIP rules regarding weather conditions that help to mitigate noise. Use of man-portable equipment for DGM will minimize noise and visual disturbance.

BMP I-2: Minimize dust during construction activities by spraying water or techniques such as laying biodegradable mats, tarps, or materials (already in EM385-1-1)	**Date:** 12/21/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☒ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☒ BMP otherwise required? If checked, required by: *EM385-1-1*

Notes (including discussion of possible value of implementing the BMP):

Not an issue since no heavy equipment will be used (e.g., shovels will be used for digging).

BMP Category I: Safety and Community

BMP I-3: Select transportation routes for trucks and heavy equipment that minimize impacts to residential areas to maximize safety and minimize noise and other aesthetic impacts	**Date:** 12/21/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☒ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *No use of heavy equipment is planned.*	

BMP I-4: Minimize drawdown of the water table in areas that could impact production rates at supply wells and/or irrigation wells	**Date:** 12/21/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☒ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP is not applicable for this project.*	

BMP Category I: Safety and Community

BMP I-5: Minimize amount of time that heavy machinery is needed to enhance safety	**Date:** 12/21/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☒ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

No use of heavy equipment is planned.

BMP I-6: Minimize handling of dangerous chemicals by selecting alternate chemicals and/or engineering to minimize contact with chemicals (for MMRP projects, there is enhanced risk related to explosion potential and exposure to chemical agents (CA) and agent breakdown products (ABP) associated with RCWM responses)	**Date:** 12/21/11 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☒ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Handling of explosives will be minimized. The Sheriff's office will store and transport explosives. By storing explosives nearby, the number of long trips with explosives will be minimized.

BMP Category I: Safety and Community

BMP I-7: Contribute to local economy when possible Examples: - Consider leasing local office space - Purchase or lease equipment from local vendors - Hire workers from local community	**Date:** 12/21/11 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Will buy supplies from local vendors whenever possible. Staying in local hotels and eating at restaurants during field work will provide benefit to local economy.

BMP Category J: Other Site-Specific BMPs

BMP J-1:

Date:

☐ Applicable

☐ Evaluated

☐ Practical

Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☐ Not Yet ☐ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

BMP J-2:

Date:

☐ Applicable

☐ Evaluated

☐ Practical

Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☐ Not Yet ☐ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

APPENDIX B

Assumptions for SiteWise Input and Other Calculations, BMTA – Fort Missoula:

Alternative 1 – Planned RI/FS Activities

Appendix B
Assumptions for SiteWise Input and Other Calculations
Blue Mountain Training Area (BMTA) GSR Evaluation
Planned RI/FS Activities (Baseline)

Baseline Remedy – Planned RI/FS Activities – SiteWise "Alternative 1" Directory

According to the Draft Workplan (February 2011), the overall RI approach includes the following:

- Development of Data Quality Objectives (DQOs) and data needs through the Technical Project Planning (TPP) process.
- Geophysical investigations utilizing both analog mag & dig and DGM techniques to delineate the extent of potential MEC.
- Intrusive investigation of anomalies to evaluate the nature and extent of MEC.
- Soil sampling and laboratory analysis to evaluate MC against accepted criteria.
- Removal and disposal of MEC, as necessary.
- Reporting of results through the TPP process throughout the RI to gain stakeholder concurrence.
- Update the CSM and MRSPP.
- Submittal of RI Report.

The notes pertaining to SiteWise input are organized by the following sections of SiteWise input:

- RI Mobilization – Uses "Remedial Action Investigation" tab of SiteWise input for SiteWise "Alternative 1"
- Equipment and Materials – Uses "Remedial Action Construction" tab of SiteWise input for SiteWise "Alternative 1"
- Meetings – Uses "Longterm Monitoring" tab of SiteWise input for "SiteWise "Alternative 1"

Note the Project Team also provided information regarding transportation for "drill and GW sampling", but since no such sampling is intended for the BMTA, the GSR Team believes those estimates are for other MRSs and are not included in the footprint for this pilot project.

For each section of SiteWise, all the sections are listed, with pertinent information added only for those sections of the input sheet where data were added. Other calculations done outside of SiteWise are then presented. These include the following:

- % of total energy from renewable resources
- Hazardous air pollutants
- Refined material use
- Unrefined material use

Baseline – Overview

- Tons of non-hazardous waste
- Tons of hazardous waste
- Risks to on-site works and from transportation
- Heavy truck trips through residential areas

Additional tables are attached which show how SiteWise outputs were split into “direct” and “indirect” energy use and greenhouse gas emissions. For definitions of direct and indirect energy use and emissions, please refer to section 2.2.2 of the evaluation report.

Overall project costs were not provided, therefore the cost sheets and net present value calculations typically included in pilot project GSR evaluations are not included for this project.

Baseline – RI Mobilization

<u>*Scope of Work*</u>

Information provided by the Project Team:

Description / Approx # Trips	Approx # People Per Trip	Approx Miles Per Trip (Round Trip) unless noted in comments	Mode of Transport	Comments (If Any)
RI Mob **/ 1	14	2400	Airplane	
RI Mob** / 1	14	4 / 50mi / 125 mi one way*	Van	(#Cars / Mi – In Town Trip / Mi Missoula-Helena One-Way)
RI Mob / 1	14	ATV 100mi on Blue Mountain Site only.	ATV	2 Mule-ATV Carts – Diesel Biodiesel will be used if available
RI Mob / 1	14	PU Trucks – limited on site, just around the area roads less 75mi	Light Truck	Gasoline

**Project Team information indicated 250 miles one way, but GSR Team believes 125 miles one-way was intended.*

***For these mobilization items, GSR Team then divides total miles by 3 since one mobilization is being used for 3 projects, and BMTA is only one of the three MRS projects.*

GSR Team assumes that the 2 ATV's will have 2 passengers at a time for risk calculations.

GSR Team assumes 7 pickup trucks, with 2 passengers at a time for risk calculations.

Baseline – RI Mobilization

<u>SiteWise Input – Input into "Remedial Action Investigation" tab of SiteWise "Alternative 1"</u>

- Material Production
    - Well Materials
    - Treatment Chemicals & Materials
    - GAC
    - Construction Materials
    - Well Decommissioning

- Transportation
    - Personnel Transportation – Road
        - Trip 1 – SUVs used to represent vans. 4 vehicles, 50 miles in town plus 250 miles round trip from Helena to Missoula = 300 total miles. Then divide total miles by three since BMTA is one of three projects under same mob (300 / 3 = 100).
        - Trip 2 – Car used to represent ATV use at Blue mountain site, 2 ATVs, 100 miles total per ATV. Input 2 passengers per ATV trip for risk calculations. Assume 20 miles per gallon. Assume Biodiesel used if available.
        - Trip 3 – Light truck, gasoline, assume 7 trucks, 75 miles total per truck, input 2 passengers per truck trip for risk calculations.
    - Personnel Transportation – Air
        - Trip 1 – 1 trip, 14 people, 2400 miles each round trip. Then divide total miles by three since BMTA is one of three projects under same mob (2400 / 3 = 800).
    - Personnel Transportation – Rail
    - Equipment Transportation – Road
    - Equipment Transportation – Air
    - Equipment Transportation – Rail
    - Equipment Transportation – Water

- Equipment Use
    - Earthwork
    - Drilling
    - Pump operation
    - Diesel and Gasoline Pumps
    - Blower, Compressor, Mixer, and Other Equipment
    - Generators
    - Agricultural Equipment
    - Capping Equipment
    - Mixing Equipment

- Residual Handling
    - Residue Disposal/Recycling
    - Landfill Operations
    - Thermal/Catalytic Oxidizers
    - Water Consumption
    - Landfill Methane Emissions

- Other Known On-Site Activities
    - CO2 Emissions

Baseline – Drill and GW Sampling

Scope of Work

Based on information provided by the Project Team:

Type	Type of Transport (Truck, FedEx, etc)	Approximate Weight (lbs)	Approximate One-Way Miles	Comments (If Any)
Explosives	Sheriff's Truck	~100 lbs	100 mi	
Sand	Local Truck	~1,200 lbs	25 mi	
Geophysical equipment	Local Subcontractor Helena		5 mi in Helena 125 mi Helena to Missoula	
Sampling Supplies	FedEx*	100 lbs	1,400 mi	No returns
Sample Coolers for Samples	Fed Ex*	100lbs / 250 lbs	800 mi	Empty to site / On ice to lab

**Assume air transport*

Baseline – Drill and GW Sampling

SiteWise Input – Input into "Remedial Action Construction" tab in SiteWise "Alternative 1"

- Material Production
  - Well Materials
  - Treatment Chemicals & Materials
  - GAC
  - Construction Materials
  - Well Decommissioning

- Transportation
  - Personnel Transportation – Road
  - Personnel Transportation – Air
  - Personnel Transportation – Rail
  - Equipment Transportation – Road
    - Trip 1 – Explosives transport to and from site. Sheriff's truck (assume light truck, gasoline) transporting ~100 lbs (0.05 tons) of explosives 100 miles one-way (200 miles round trip). Assume explosives will not be used and will be returned to the sheriff's office (so footprint for materials not quantified). Since it is assumed that the explosives won't be used, assume same weight transported in return trip.
    - Trip 2 – Sand transport to and from site. Local truck (assume light truck, gasoline) transporting ~1,200 lbs (0.6 tons) of sand 25 miles one-way (50 round trip). Assume sand will not be used and will be re-used elsewhere (so footprint for materials not quantified). Since it is assumed that the sandbags won't be used, assume same weight transported in return trip.
    - Trip 3 – Geophysical equipment transported to and from the site by a local subcontractor. 5 miles one-way in Helena and 125 miles one-way from Helena to Missoula (260 miles round trip). Assume ~100 lbs and gasoline for fuel type.
  - Equipment Transportation – Air
    - Trip 1 – Sampling supplies shipped via Fed Ex to site. 100 lbs (0.05 tons) of supplies shipped 1,400 miles one way via air.
    - Trip 2 – Sample coolers shipped via Fed Ex to and from site. 100 lbs for empty coolers shipped 800 miles to the site and 250 lbs for coolers shipped 800 miles to lab with samples and ice. Average shipping weights for round trip. ((100+250) / 2 = 175 lbs /2000 = .0875 tons for a 1600 mile RT)
  - Equipment Transportation – Rail
  - Equipment Transportation – Water

- Equipment Use
  - Earthwork
  - Drilling
  - Pump operation
  - Diesel and Gasoline Pumps
  - Blower, Compressor, Mixer, and Other Equipment
  - Generators
  - Agricultural Equipment
  - Capping Equipment
  - Mixing Equipment

Baseline – Drill and GW Sampling

- Residual Handling
    - Residue Disposal/Recycling
    - Landfill Operations
    - Thermal/Catalytic Oxidizers
    - Water Consumption
    - Landfill Methane Emissions

- Other Known On-Site Activities

Baseline – Meetings

Scope of Work

Based on information provided by the Project Team:

Description / Approx # Trips	Approx # People Per Trip	Approx Miles Per Trip (Round Trip) unless noted in comments	Mode of Transport	Comments (If Any)
PM - KO Meetings / 4	2	1600	Airplane	
Public Meetings / 4	6	2000	Airplane	
Additional Stakeholder Meetings / 2	2	1600	Airplane	
PM - KO Meetings / 4	2	1 / 50mi / 125 mi	Car	(#Cars / Mi – In Town Trip / Mi Missoula-Helena One-Way) In Town / plus one trip to other city assumes Mob in and out of different City (125 Miles Helena to Missoula)
Public Meetings / 4	6	2 / 50mi / 125mi	Car	(#Cars / Mi – In Town Trip / Mi Missoula-Helena One-Way)
Additional Stakeholder Meetings / 2	2	1 / 50mi / 125mi	Car	(#Cars / Mi – In Town Trip / Mi Missoula-Helena One-Way)

Note that the GSR Team assumes these trips are for BMTA only.

Baseline – Meetings

<u>SiteWise Input – Input into “Longterm Monitoring” tab in SiteWise “Alternative 1”</u>

- Material Production
    - Well Materials
    - Treatment Chemicals & Materials
    - GAC
    - Construction Materials
    - Well Decommissioning

- Transportation
    - Personnel Transportation – Road
        - Trip 1 – 4 trips for PM-KO meetings, 2 people per trip, 1 car, 50 miles each in town plus 250 miles round trip Helena to Missoula = 300 total miles
        - Trip 2 – 4 trips for public meetings, 6 people per trip, 2 cars, 50 miles each in town plus 250 miles round trip Helena to Missoula. Assume 3 people per car.
        - Trip 3 – 2 trips for additional stakeholder meetings, 2 people per trip, 1 car, 50 miles each in town plus 250 miles round trip Helena to Missoula
    - Personnel Transportation – Air
        - Trip 1 – 4 trips for PM-KO meetings, 2 people per trip, 1600 miles round trip
        - Trip 2 – 4 trips for public meetings, 6 people per trip, 2000 miles round trip
        - Trip 3 – 2 trips for additional stakeholder meetings, 2 people per trip, 1600 miles round trip
    - Personnel Transportation – Rail
    - Equipment Transportation – Road
    - Equipment Transportation – Air
    - Equipment Transportation – Rail
    - Equipment Transportation – Water

- Equipment Use
    - Earthwork
    - Drilling
    - Pump operation
    - Diesel and Gasoline Pumps
    - Blower, Compressor, Mixer, and Other Equipment
    - Generators
    - Agricultural Equipment
    - Capping Equipment
    - Mixing Equipment

- Residual Handling
    - Residue Disposal/Recycling
    - Landfill Operations
    - Thermal/Catalytic Oxidizers
    - Water Consumption – Purge water from sampling is negligible
    - Landfill Methane Emissions

- Other Known On-Site Activities

Other Supporting Calculations
Blue Mountain Training Area (BMTA) GSR Evaluation
Planned RI/FS Activities (Baseline)

% of Total Energy Usage from Renewable Resources

- None identified – not the only significant energy use for this pilot project is fuel for transportation.

Hazardous Air Pollutants

- None identified

.

Refined Materials Use

- Explosives – assume none will be needed and un-used will be donated to Sheriff for future beneficial use, so “none” is assigned for BMTA.

- Other refined materials assumed to be negligible.

Unrefined Materials Use

- Sand from local quarry for sandbags - assume none will be needed and un-used will be donated to MTARNG for future beneficial use, so “none” is assigned for BMTA.

Tons of Non-Hazardous Waste

- None identified

Tons of Hazardous Waste

- None identified

Risks to On-Site Workers and from Transportation

- Refer to “Total” tab of the “Summary.xlsx” spreadsheet
- For transportation related risks, sum injuries and fatalities for all transportation activities
- Add total risk form transportation and non-transportation, and then subtract the transportation sums previously calculated, to get non-transportation

Heavy Truck Trips through Residential Areas

- No heavy equipment assumed for BMTA.

GSR Team Calculations to Split Energy Results from SiteWise into "Direct" and "Indirect"

phase	Reported by SiteWise activity	Reported by SiteWise energy used (MMBTU)	Assigned by GSR Team from SiteWise Output: Scope 1 (direct) energy used (MMBTU)	Assigned by GSR Team from SiteWise Output: Scope 2 (indirect) energy used (MMBTU)	Assigned by GSR Team from SiteWise Output: Scope 3 (indirect) energy used (MMBTU)	Added by GSR Team: Scope 3 (indirect) energy used (MMBTU)	Total Calculated by GSR Team
remedial investigation	Consumables	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	44.86	1.39	0.00	43.47	10.50	55.37
	Transportation-Equipment	0.00	0.00	0.00	0.00	0.00	0.00
	Equipment Use and Misc	0.00	0.00	0.00	0.00	0.00	0.00
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-Total	44.86	1.39	0.00	43.47	10.50	55.37
remedial action construction	Consumables	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Equipment	9.91	0.00	0.00	9.91	2.38	12.29
	Equipment Use and Misc	0.00	0.00	0.00	0.00	0.00	0.00
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-Total	9.91	0.00	0.00	9.91	2.38	12.29
remedial action operations	Consumables	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Equipment	0.00	0.00	0.00	0.00	0.00	0.00
	Equipment Use and Misc	0.00	0.00	0.00	0.00	0.00	0.00
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-Total	0.00	0.00	0.00	0.00	0.00	0.00
longterm monitoring	Consumables	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	240.84	0.00	0.00	240.84	57.80	298.64
	Transportation-Equipment	0.00	0.00	0.00	0.00	0.00	0.00
	Equipment Use and Misc	0.00	0.00	0.00	0.00	0.00	0.00
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-Total	240.84	0.00	0.00	240.84	57.80	298.64
total		295.62	1.39	0.00	294.23	70.68	366.30

Note: For energy use related to fuel use for transportation or on-site equipment use, SiteWise reports energy use associated with combustion only. The added Scope 3 energy use for these activities take into account upstream energy use (i.e. energy required for extraction, refining, etc.). The added energy is based on multipliers used in the GREET software, version 1.8d.1, which in this case equates to multiplying energy used in fuel combustion by 0.24 for gasoline and diesel and 0.05 for biodiesel 20 to calculate the upstream energy use.

All energy use related to personnel transport is considered to be Scope 3 (indirect), except for on-site use of ATVs, which is considered to be Scope 1 (direct). Pickup truck use is assumed to be mostly off-site, and is therefore considered to be Scope 3 (indirect).

GSR Team Calculations to Split GHG Results from SiteWise into "Direct" and "Indirect"

phase	Reported by SiteWise		Assigned by GSR Team from SiteWise Output			Added by GSR Team	Total Calculated by GSR Team
			Scope 1 (direct)	Scope 2 (indirect)	Scope 3 (indirect)	Scope 3 (indirect)	
	activity	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	
remedial investigation	Consumables	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	3.87	0.08	0.00	3.79	0.91	4.78
	Transportation-Equipment	0.00	0.00	0.00	0.00	0.00	0.00
	Equipment Use and Misc	0.00	0.00	0.00	0.00	0.00	0.00
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-Total	3.87	0.08	0.00	3.79	0.91	4.78
remedial action construction	Consumables	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Equipment	1.05	0.00	0.00	1.05	0.25	1.30
	Equipment Use and Misc	0.00	0.00	0.00	0.00	0.00	0.00
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-Total	1.05	0.00	0.00	1.05	0.25	1.30
remedial action operations	Consumables	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Equipment	0.00	0.00	0.00	0.00	0.00	0.00
	Equipment Use and Misc	0.00	0.00	0.00	0.00	0.00	0.00
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-Total	0.00	0.00	0.00	0.00	0.00	0.00
longterm monitring	Consumables	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	20.81	0.00	0.00	20.81	4.99	25.80
	Transportation-Equipment	0.00	0.00	0.00	0.00	0.00	0.00
	Equipment Use and Misc	0.00	0.00	0.00	0.00	0.00	0.00
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-Total	20.81	0.00	0.00	20.81	4.99	25.80
Total		25.72	0.08	0.00	25.64	6.16	31.88

Note: For GHG emissions related to fuel use for transportation or on-site equipment use, SiteWise reports emissions associated with combustion only. The added Scope 3 emissions for these activities take into account upstream emissions (i.e. emissions related to extraction, refining, etc.). The added emissions factor is based on multipliers used in the GREET software, version 1.8d.1, which in this case equates to multiplying emission from fuel combustion by 0.24 for gasoline and diesel and 0.05 for biodiesel 20 to calculate the upstream emissions.

All emissions related to personnel transport are considered to be Scope 3 (indirect), except for on-site use of ATVs, which is considered to be Scope 1 (direct). Pickup truck use is assumed to be mostly off-site, and is therefore considered to be Scope 3 (indirect).

FINAL REPORT

PILOT PROJECT GSR EVALUATION: SHEPLEY'S HILL LANDFILL – DRAFT FFS PHASE

Former Fort Devens Army Installation, Devens, MA

Prepared for:

U.S. Army Corps of Engineers
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Contract No. W912DQ-08-D-0019
Delivery Order No. ZW02

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March 2011

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PREFACE

The US Army Engineering and Support Center, Huntsville (USAESCH), Environmental and Munitions Center of Expertise (EM CX) has contracted Tetra Tech EC, Inc. (Tetra Tech) under Contract W912DQ-08-D-0019, Delivery Order No. ZW02, to conduct and document a Study that follows the process of considering, incorporating, documenting, and evaluating the benefits of green and sustainable remediation (GSR) practices. The objective of this Task Order is to: (1) Follow the consideration and incorporation of GSR practices into Army environmental remediation projects; (2) Ascertain the effectiveness of the GSR practices that are considered and incorporated; and (3) Provide procedures by which GSR practices that are shown to be effective can be identified, considered, implemented and documented by Project Teams working on Army sites. The information obtained from this Study will be used to provide recommendations to the Office of the Assistant Chief of Staff for Installation Management (OACSIM) for development of Army-wide GSR guidance and policy. This document has been prepared in accordance with the Task Order Statement of Work (SOW) entitled "*Evaluation of Consideration and Incorporation of Green and Sustainable Remediation (GSR) Practices in Army Environmental Remediation*" (26 July 2010).

The Project Delivery Team (PDT) consists of representatives and subject matter experts (SMEs) from the following organizations:

- EM CX;
- OACSIM;
- National Guard Bureau (NGB);
- Army Environmental Command (AEC);
- Tetra Tech;
- Office of the Deputy Assistant Secretary of the Army-Environmental Safety and Occupational Health (ODASA (ESOH));
- Headquarters US Army Corps of Engineers (HQ USACE) Formerly Used Defense Sites (FUDS) program;
- HQ USACE Environmental Community of Practice (ECoP) Military Munitions Support Services (M2S2);
- Huntsville Center Environmental Program; and
- Army Environmental Policy Institute (AEPI)

Specific representatives of those organizations are listed on the table at the end of this preface. This report pertains to one of the pilot projects conducted as part of the Study. Tetra Tech personnel who provided the most significant contributions to this report are as follows:

- Preparation
    - Doug Sutton (IRP GSR Technical Lead)
    - Sarah Farron

- Review
    - Rob Greenwald (Project Manager)

Sincere thanks are extended to Project Team associated with this pilot project, for their willingness to participate in this Study and for their efforts that were associated with their participation.

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Doug Sutton, PhD, PE, LEED

3/4/11
Date

ACRONYMS AND ABBREVIATIONS

ACSIM	Assistant Chief of Staff for Installation Management
AEC	Army Environmental Command
AEPI	Army Environmental Policy Institute
BMPs	Best Management Practices
BRAC	Base Realignment and Closure
CO2	Carbon dioxide
CO2e	Equivalent Global Warming Potential of Carbon Dioxide
CSM	Conceptual Site Model
DoD	Department of Defense
ECoP	Environmental Community of Practice
EM CX	Environmental and Munitions Center of Expertise
ESOH	Environment, Safety, and Occupational Health
FFS	Focused Feasibility Study
FUDS	Formerly Used Defense Sites
GAC	Granular Activated Carbon
GHG	Greenhouse gas
gpm	Gallons per minute
GSR	Green and Sustainable Remediation
HDPE	High-density polyethylene
HP	Horsepower
HQ USACE	Headquarters US Army Corps of Engineers
HRS	Hours
IRP	Installation Restoration Program
Kg	Kilograms
kWh	Kilowatt-hours
L	Liters
lbs	Pounds
LTM	Long Term Monitoring
M2S2	Military Munitions Support Services
MMBtu	Million Metric British Thermal Units
MMRP	Military Munitions Response Program
MNA	Monitored Natural Attenuation
MWh	Megawatt hours
NEWE	Northeast Power Coordinating Council, Inc., New England
NGB	National Guard Bureau
NOx	Nitrogen Oxides
NPV	Net present value
O&M	Operations and Maintenance
OACSIM	Office of the Assistant Chief of Staff for Installation Management
ODASA	Office of the Deputy Assistant Secretary of the Army
P&T	Pump and Treat
PDT	Project Delivery Team
PM	Particulate Matter
POTW	Publicly Operated Treatment Works
PRAP	Proposed Remedial Action Plan
PRB	Permeable Reactive Barrier
RECs	Renewable Energy Certificates
ROD	Record of Decision

RSE	Remedial System Evaluation
SiteWise	Battelle SiteWise™ Sustainable Environmental Remediation Tool
SMEs	Subject matter experts
SOW	Statement of Work
SOx	Sulfur Oxides
SVOC	Semi-volatile organic compound
TT	Tetra Tech
US	United States
USACE	United States Army Corp of Engineers
USAESCH	US Army Engineering and Support Center, Huntsville
VFD	Variable Frequency Drive
VOC	Volatile organic compound
ZVI	Zero-Valent Iron

1.0 INTRODUCTION

1.1 ACSIM GSR STUDY AND PURPOSE OF THIS GSR EVALUATION

The US Army Engineering and Support Center, Huntsville (USAESCH), Environmental and Munitions Center of Expertise (EM CX) has contracted Tetra Tech EC, Inc. (Tetra Tech) under Contract W912DQ-08-D-0019, Delivery Order No. ZW02, to conduct and document a Study that follows the process of considering, incorporating, documenting, and evaluating the benefits of green and sustainable remediation (GSR) practices (hereafter referred to as "the Study"). The objective of the Study is to: (1) Follow the consideration and incorporation of GSR practices into Army environmental remediation projects; (2) Ascertain the effectiveness of the GSR practices that are considered and incorporated; and (3) Provide procedures by which GSR practices that are shown to be effective can be identified, considered, implemented and documented by project teams working on Army sites. The information obtained from this Study will be used to provide recommendations to the Office of the Assistant Chief of Staff for Installation Management (OACSIM) for development of Army-wide GSR guidance and policy.

One component of the Study described above is to perform a GSR evaluation at 12 Army "Pilot Projects" that are in various phases of the remedial process. This report presents the Pilot Project GSR Evaluation in the Draft Focused Feasibility Study (Draft FFS) phase at the Former Fort Devens Army Installation, Devens, MA (hereafter referred to as "Shepley's Hill Landfill"). This GSR evaluation has been conducted using an approach developed during the Study and documented in the following report: *Process for Consideration and Incorporation of Green and Sustainable Remediation (GSR) Practices in Army Environmental Remediation (draft final dated 9 February 2011)*. One purpose for the pilot projects is to provide testing of the GSR approach developed during the Study, and that approach will be refined and finalized later in the Study based on lessons learned from this and other pilot projects. In addition, it is anticipated that this GSR evaluation will provide the Project Team for Shepley's Hill Landfill with information and/or recommendations that will be beneficial for their project.

This report refers to "teams" that are defined as follows:

- Study Team: This is the team conducting a Study being led by USACE EM CX that follows the process of considering, incorporating, documenting, and evaluating the benefits of green and sustainable remediation practices for Army projects.

- Project Team: Refers to those associated with implementation of the remedial process for the pilot projects.

- GSR Team: Refers to the personnel that perform a specific GSR evaluation. For this Study, the GSR Team consists of personnel from Tetra Tech, which is a contractor to USACE for the Study.

In this Study, an "EM CX liaison" for each of the pilot projects serves as a bridge between the USACE Study project manager (Carol Dona), the Study contractor performing the GSR evaluation (Tetra Tech), and the Project Team manager for the specific pilot. For this pilot project the EM CX Liaison is Dave Becker.

1.2 TECHNICAL OVERVIEW: SHEPLEY'S HILL LANDFILL

1.2.1 Overview of Site Location, Setting, and Contamination

Shepley's Hill Landfill encompasses approximately 84 acres in the northeast corner of the main post of the former Fort Devens (Figure 1-1), which is located approximately 35 miles northwest of Boston, Massachusetts. The landfill is bordered to the northeast by Plow Shop Pond, to the west by Shepley's Hill, to the south by recent commercial development, and to the east by land formerly containing a railroad roundhouse. Nonacoicus Brook, which drains the pond, lies to the north of the landfill.

The primary contaminant in groundwater is arsenic. Groundwater impacted by arsenic flows predominantly to the north and some groundwater impacted by arsenic also flows to the east towards the Red Cove area of Plow Shop Pond.

1.2.2 Remedial Phase and Status

A pump-and-treat (P&T) system was implemented in 2006 as a contingent remedy under the 1995 Record of Decision (ROD). The contingent remedy was triggered because monitoring results indicated that the initial remedy (landfill cap) would likely not achieve cleanup standards within the timeframe established in the ROD. The P&T system has been operating since March 2006, and the combined pumping rate from the two extraction wells at the north end of the landfill was increased from 25 to 50 gpm in 2007.

A Draft FFS dated December 2010, was provided to the GSR Team for an initial GSR evaluation (Draft FFS Phase) that considered alternatives to the current P&T system as well as two alternatives to address groundwater flux to Red Cove area of Plow Shop Pond (a barrier wall with a permeable reactive portion, or a barrier wall alone). The GSR evaluation is based on the December 2010 Draft FFS, and does not address FFS modifications that occurred subsequent to the December 2010 Draft FFS.

This GSR evaluation considers the following remedy alternatives described in the December 2010 Draft FFS:

- Alternatives for groundwater flux to the north (all include the existing landfill cap)
    - Alternative 1: No Action (Current P&T Remedy - Baseline Option)
    - Alternative 2: Monitored Natural Attenuation (MNA)
    - Alternative 3: P&T with Reinjection
    - Alternative 4: Permeable Reactive Barrier (PRB)
- Alternatives for groundwater flux to Red Cove
    - Alternative A: Barrier Wall/PRB
    - Alternative B: Barrier Wall

This GSR evaluation provides an evaluation of the alternatives listed above with respect to specific GSR metrics, and also highlights how specific GSR Best Management Practices (BMPs) have been implemented in the current P&T operation and/or could be incorporated into other alternatives. However, this GSR evaluation does not in any manner include an evaluation or judgment of the protectiveness of any of these alternatives. It is intended that this GSR evaluation in the "Draft FFS

Phase" will serve as a secondary decision factor in alternative selection (i.e., not part of primary decision criteria associated with remedy selection). Because this GSR evaluation has been performed during the Draft FFS phase, the focus is to present and compare GSR aspects of the various alternatives. After a remedy is selected, a more detailed GSR evaluation regarding design aspects of the selected alternative can be performed, perhaps between the 30 percent and 60 percent design.

1.3 DOCUMENTS REVIEWED AND CALLS/MEETINGS CONDUCTED

The following project documents were reviewed for this evaluation:

- *Draft Focused Feasibility Study* (Sovereign Consulting, December 2010)
- *Remediation System Evaluation & Green Remediation Evaluation* (GeoTrans, 21 August 2009)

As per the GSR approach being implemented in the Study, an introductory conference call (referred to as the "Step 3" call) was conducted on 21 January 2011. Items discussed on this call included the following:

- The schedule of the GSR evaluation was discussed within the context of how the GSR evaluation could best be integrated into the overall efforts and schedule of the Project Team.
- It was determined that there would be two GSR evaluations conducted for this project; one based on the December 2010 Draft FFS and one during the design. In the case of the GSR evaluation during the Draft FFS phase, the goal is to make GSR a secondary decision factor in alternative selection, and in the design phase the goal is further greening of the selected remedy.
- The subsequent "Step 5" call, which would serve as a primary mechanism for the GSR Team and Project Team to exchange information and ideas, was scheduled for 9 February 2011.

Participants for the "Step 3" call are listed in Table 1-1.

Table 1-1
Step 3 Call Participants, 21 January 2011

Participants*			
Name	**Organization**	**Phone**	**Email**
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** Dave Becker, the EM CX liaison, could not attend this call. Carol Dona received his input prior to the call.*

A more detail conference call, referred to as the "Step 5" conference call, was conducted on 9 February 2011 and lasted two hours. During this call the GSR Team used the list of GSR BMPs developed for the Study as an outline to ask questions to the Project Team and allow the Project Team to provide pertinent information to the GSR Team. Participants for the "Step 5" call are listed in Table 1-2.

Table 1-2
Step 5 Call Participants, 9 February 2011

Participants*			
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1.4 STRUCTURE OF THIS REPORT

This GSR evaluation report is structured as follows:

- Section 1: Introduction
- Section 2: Key GSR Findings
    - Review of BMPs
    - Quantitative Footprint Analysis for Alternative 1 (Current P&T Remedy – Baseline Option)
    - Footprint Impacts for Alternatives 2 to 4 (Compared to Alternative 1)
    - Footprint Analysis for Alternatives A and B (Red Cove)
    - Other Qualitative Considerations
- Section 3: GSR Recommendations

Supporting information and calculations for quantitative aspects of the evaluation are provided in appendices, and spreadsheet files for the SiteWise tool (Version 1.0) are attached electronically.

2.0 KEY GSR FINDINGS

2.1 REVIEW OF BEST MANAGEMENT PRACTICES (BMPs)

2.1.1 BMP Tables Completed by GSR Team

The GSR Team and the Project Team used a list of GSR BMPs as an outline to exchange information and ideas pertinent to application of GSR practices for this pilot project. The GSR Team subsequently completed the BMP tables included in Appendix A, based on the data provided by the Project Team in the form of documents as well as discussions during the Step 5 conference call. Table 2-1 summarizes information entered on the BMP tables in Appendix A, specifically with respect to the number of BMPs that appear to be applicable for this pilot project, the number of BMPs that appear to be practical for this pilot project, the number of BMPs that have been implemented prior to this GSR evaluation, and the number of BMPs that maybe associated with potential cost savings for this pilot project.

Table 2-1
Summary of BMP Applicability and Implementation from BMP Tables in Appendix A

	BMP Category								
	A. Planning	B. Characterization and/or Remedy Approach	C. Energy/Emissions Transportation	D. Energy/Emissions Equipment Use	E. Materials & Off-site Services	F. Water Resource Use	G. Waste Generation, Disposal, and Recycling	H. Land Use, Ecosystems, and Cultural Resources	I. Safety and Community
Total Number of BMPs	10	9	4	11	5	5	6	7	7
Number of Applicable BMPs	6	9	2	6	3	0	2	1	2
Number of Practical BMPs	5	6	2	2	0	0	2	1	2
Number of BMPs Implemented Prior to GSR Evaluation									
- Fully	2	4	1	2	0	0	2	1	2
- Partially	2	1	1	0	0	0	0	0	0
- Not Yet	1	1	0	0	0	0	0	0	0
Number of Practical BMPs Likely to Result in Cost Savings	2	4	1	2	0	0	1	0	1

2.1.2 Key Findings Regarding BMPs

Completing the GSR BMP tables in Appendix A is somewhat more difficult during the Draft FFS phase than during design or O&M, because some BMPs are applicable to some alternatives but not others. For this specific GSR evaluation, two of the alternatives assume active remediation for 100 years, but the other alternatives have no active system. Therefore, the "notes" section for many of the BMPs indicates that the BMP might apply depending on which alternative is selected.

An overview of key findings regarding application of the BMPs to this pilot project is provided below.

- The Project Team has already considered many of the BMPs prior to this GSR evaluation. Examples include the following:
  - Electronic report deliverables and use of teleconferences rather than in-person meetings when possible.
  - Continuing to update the conceptual site model in an attempt to optimize the remedy, and evaluating remedial alternatives to the current P&T system that have the potential to significantly lower the environmental footprint of the remedy.
  - Using dynamic field techniques such as GeoProbe for plume delineation, and using arsenic and iron field test kits.
  - Encouraging carpooling and minimizing shipments (chemicals, waste disposal).
  - Using variable frequency drive (VFD) motors on the extraction wells and microfilter pumps in the treatment plant.
  - Identifying an entry point to the site for heavy equipment with less potential to disturb residences.
  - Utilizing local contractors when possible to benefit the local community.
- While going through the BMP list on the Step 5 call, the GSR Team suggested several items that the Project Team could consider moving forward. Some examples include the following:
  - Submitting appendices and lab reports for future deliverables electronically to save paper and perhaps shipping (this is already the preferred protocol but has not always occurred).
  - Using extracted water for heating and cooling (as suggested in the RSE) if P&T continues in the future.
- The Project Team identified that some BMPs are not practical to implement because of other project-specific constraints. Examples include the following:
  - Purchasing Renewable Energy Certificates (RECs) to offset footprints associated with electricity usage is not considered to be practical because it increases costs. Cost is seen as a higher priority by the Project Team.

- Discharging treated water to surface water rather than the POTW (applies to Alternative 1 only) to reduce demands on the POTW is not considered to be practical because additional treatment would be required for other compounds, and also is considered not necessary because the POTW is apparently not rate-limited.

- Some BMPs are potentially applicable in a future remedial phase (system operation), but it is somewhat premature to consider them in detail during the Draft FFS phase. Some examples include the following:

  - Scheduling construction activities in appropriate seasons to reduce weather delays and perhaps reduce number of trips to the site by working longer days.

  - Incorporating green specifications into future contracts for construction and/or O&M.

  - Developing protocols to minimize idling during heavy equipment operation and/or use of alternate fuels for such equipment.

  - Minimizing erosion and soil transport to surface water bodies during future construction activities.

  - Minimizing potential impacts such as light, noise, odor, or dust during future construction activities.

2.2 QUANTITATIVE FOOTPRINT ANALYSIS FOR ALTERNATIVE 1 (BASELINE)

2.2.1 Overview of Alternative 1 (Baseline)

The baseline remedy option (referred to as "Alternative 1 – No Action" in the December 2010 Draft FFS) is a continuation of the current P&T remedy and involves the following components (see Figure 2-1 for layout):

- Maintenance of the current landfill cap.

- Continuation of P&T with extraction of groundwater from two existing extraction wells at the north end of the landfill at a maximum system flow rate of 50 gpm. The December 2010 Draft FFS assumes this system would need to operate for centuries, and provides costs for a 100-year period.

- Treatment of arsenic in extracted groundwater through co-precipitation with iron and microfiltration.

- Discharge of treated water to the Devens POTW.

- Water level monitoring at 67 monitoring wells conducted on a semi-annual basis, and water quality sampling (including analysis for arsenic) at 38 monitoring wells in the Fall and 16 of those 38 wells in the Spring (assumed to be low flow sampling).

- No capital costs are assumed, but system replacement cost of $1.5 million every 30 years is assumed in the December 2010 Draft FFS

Input to the SiteWise tool and other supporting calculations are described in Appendix B. SiteWise Version 1.0 was the version of SiteWise available at the time this evaluation was performed.

2.2.2 Summary of Quantitative Footprint Results, Alternative 1 (Baseline)

Table 2-2 summarizes the quantitative footprint results for Alternative 1. Input to the SiteWise tool and other supporting calculations are described in Appendix B. The SiteWise files utilized for this portion of the analysis are supplied electronically ("Alternative 1").

Table 2-2 divides total energy use and global warming potential into "direct" and "indirect" use and emissions. The following definitions are utilized for "direct" versus "indirect" energy use and global warming potential:

- Direct Scope 1: From sources that are owned or controlled by the reporting entity.
- Indirect Scope 2: Due to activities of the reporting entity, but occur at sources owned or controlled by another entity, from consumption of purchased electricity, heat or steam.
- Indirect Scope 3: Due to activities of the reporting entity, but occur at sources owned or controlled by another entity, other than Scope 2 (such as the extraction and production of purchased materials and fuels, transport-related activities in vehicles not owned or controlled by the reporting entity, outsourced activities, waste disposal, etc.

SiteWise reports total energy use and total global warming potential, but does not sum the "direct" and "indirect" components. The user needs to track the distinction between "direct" and "indirect" components separately, based on information contained within the SiteWise spreadsheets. The separation of the total energy and global warming potential is documented in Appendix B, which describes SiteWise input and related calculations.

Table 2-2
Summary of Quantitative Footprint for Alternative 1 (Baseline)

GSR Parameter	Unit	Value
Environmental		
Energy – Total	MMBtu	250,035
Energy – Direct Scope 1	MMBtu	45,546
Energy – Indirect Scope 2	MMBtu	89,221
Energy – Indirect Scope 3	MMBtu	115,269
% of Energy from Renewable Resources	%	6.0%
Global warming potential – Total	Metric tons CO2e	15,359
Global warming potential – Direct Scope 1	Metric tons CO2e	45
Global warming potential – Indirect Scope 2	Metric tons CO2e	5,461
Global warming potential – Indirect Scope 3	Metric tons CO2e	9,853
Criteria air pollutant emissions	Metric tons (NOx+SOx+PM)	22.3
Hazardous air pollutant emissions	Lb	negligible
Potable water use	1,000s of gallons	93,440

GSR Parameter	Unit	Value
Other water use	1,000s of gallons	2,371,800
Refined materials use	Lbs	79,000
% of refined materials from recycled material	%	0%
Unrefined materials use	Ton	negligible
% of unrefined materials from recycled material	%	N/A
Non-hazardous waste generation	Ton	18,900
Hazardous waste generation	Ton	0
% of potential waste that is recycled or reused	%	0%
Land transferred or made available for beneficial use	Acres	0
Existing ecosystem destruction	Acres	0
Time frame for land reuse	Years	not clearly specified
Flexibility and breadth of options for reuse	see below	not clearly specified
Economic		
Life-cycle Cost, Discounted (2.7% discount rate)	$	$21.1 million
Life-cycle Cost, Undiscounted	$	$62.2 million
Up-front Cost	$	$0
Societal		
Predicted number of injuries or fatalities for On-Site Worker	Number of injuries or fatalities	negligible
Predicted number of injuries or fatalities associated with transportation	Number of injuries or fatalities	1.2
One-Way Heavy Vehicle Trips through Res. Area	Trips	0

**Scale for flexibility and breadth of re-use options (greater GSR value with lower number, indicating more breadth and flexibility for potential re-use)*

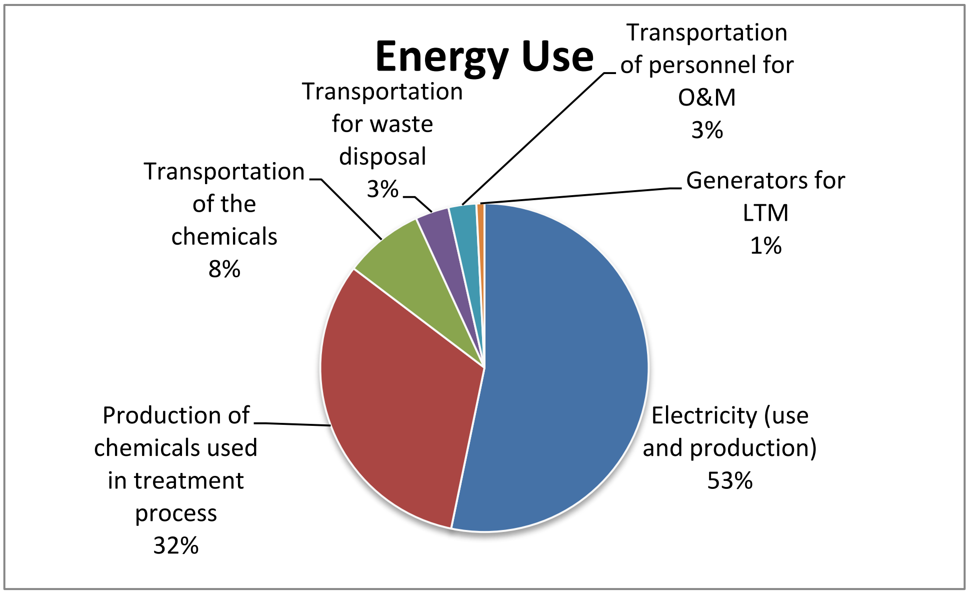
1 - Unlimited re-use options
2 - Limited re-use options
3 - Only one re-use option

2.2.3 Key Findings from Quantitative Footprint Analysis, Alternative 1 (Baseline)

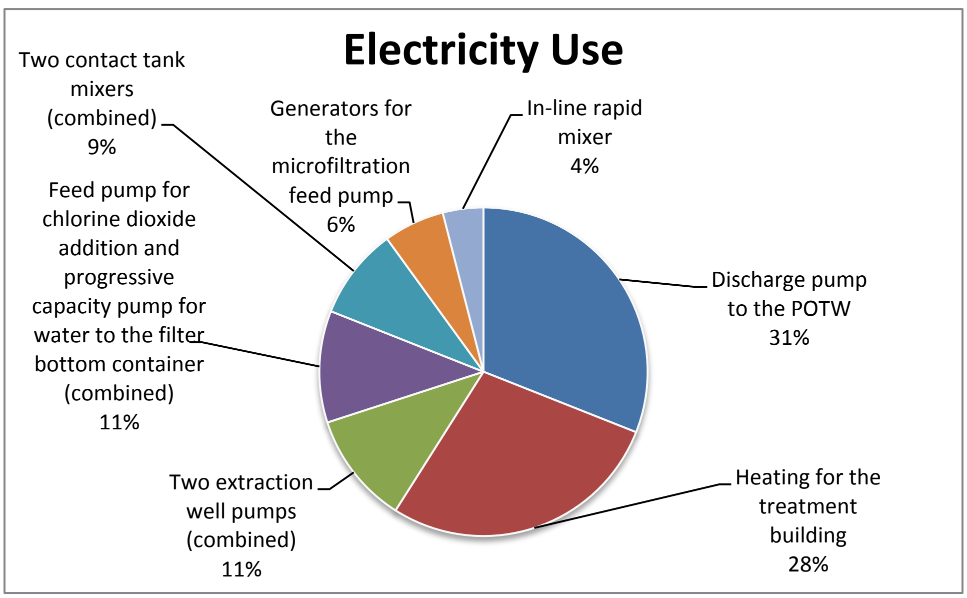
Review of the SiteWise results and supporting calculations in Appendix B indicate the following key findings with respect to the Baseline remedy design:

- From SiteWise, total energy usage over 100 years of operation is 250,035 MMBtu, and electricity use accounts for 133,165 MMBtu of that total (pumps, mixers, and heater). Thus, 53% of energy use is electricity. From www.epa.gov/egrid, generation mix for the "NEWE" subregion is 11.3% renewable resources, mostly hydro (including large hydro) and biomass. Thus, 53% x 11.3% = 6.0% of total energy use is from renewable resources.

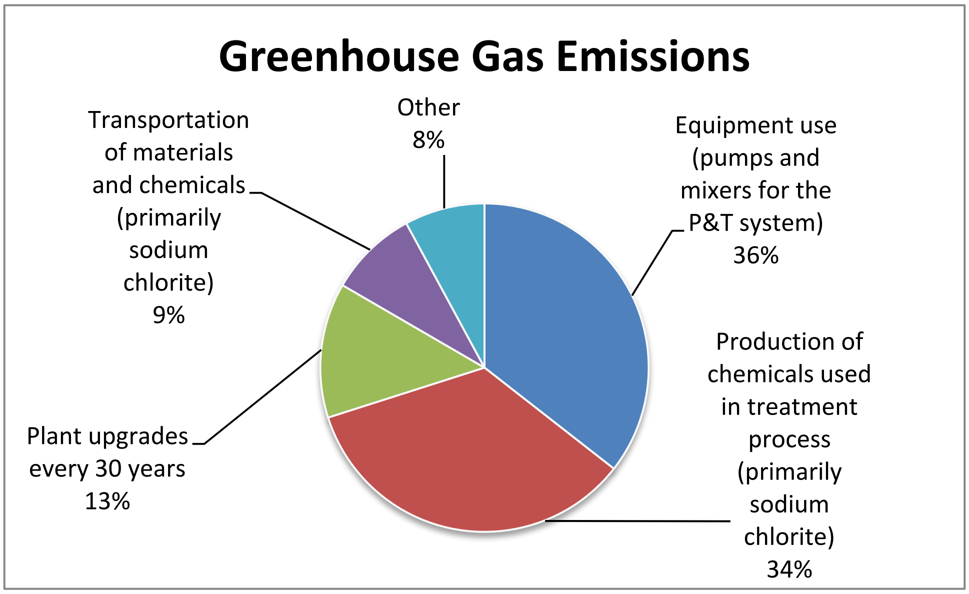
- Based on SiteWise results, the major contributors of energy use include the following:



With respect to electricity (associated entirely with operation of the P&T system), use of approximately12,900 MWh over 100 years is estimated, with the major contributors as follows:



- Based on SiteWise results, greenhouse gas emissions (i.e., global warming potential) result almost entirely (more than 99%) from operation of the P&T system, with less than 1 percent associated with sampling for LTM. The largest contributors to greenhouse gas emissions include the following:



- With respect to criteria pollutants, the dominant contributor to NOx and SOx emissions is equipment use associated with operation of the P&T system pumps and mixers, and the dominant contributor to PM is transportation of chemicals.

- The emission of hazardous air pollutants is negligible because treatment does not involve stripping of volatile organic chemicals.

- Potable water is used for polymer dilution (150 gallons per day), generation of chlorine dioxide (2,400 gallons per day), and for bi-monthly clean-in-place events (average of 10 gallons per day). Other water use is primarily associated with the extraction of groundwater which is discharged to the POTW (approximately 64,800 gallons per day). A minor amount of other water use is also calculated by SiteWise associated with production of electricity used.

- The refined materials consist of the following (assumed to be 100% virgin material):

    - 70,000 pounds per year of sodium chlorite
    - 9,000 pounds per year of chlorine gas

- The project does not involve hazardous waste generation. Non-hazardous waste consists of solids from the filter bottom.

- Future land use is not explicitly discussed in the December 2010 Draft FFS.

- A table summarizing the calculation of life-cycle cost (discounted and undiscounted) is included in Appendix B.

    - The capital cost for Alternative 1 is $0, since it does not involve any changes to the current system.

    - The annual cost of $600,000 for the first ten years and $575,000 for the subsequent ninety years is taken from Table C-1 of the December 2010 Draft FFS. Table C-1 also includes three treatment plant replacements during a 100 year period priced at $1.5 million each.

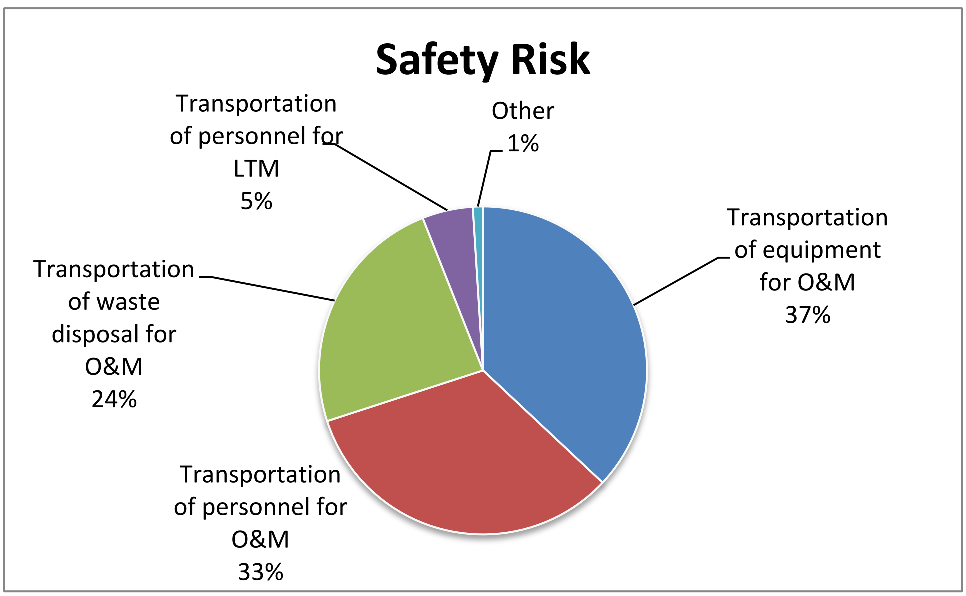
- Over 100 years these costs sum to $62.3 million undiscounted, and $21.1M in Net Present Value (NPV) based on a 2.7 percent discount rate applied to future costs, which is consistent with the discount rate applied in the December 2010 Draft FFS.

- NPV is calculated by discounting future costs to present-day dollars using the following equation:

$$PV = \frac{FV}{(1+i)^n} = C \times FV$$

PV is the present value
FV is the value in year "n" (i.e., future value)
i is the discount rate
C is the discount factor, which equals $1/(1+i)^n$

- SiteWise calculates safety risk for transportation and based on use of heavy machinery. For this remedy alternative the calculation is entirely associated with transportation. Based on SiteWise results, it would be expected that there would be 1.2 injuries or fatalities over the 100-year duration of this alternative, and the primary contributors to safety risk are as follows:



2.3 FOOTPRINTING FOR ALTERNATIVES 2 TO 4 (COMPARED TO ALTERNATIVE 1)

The GSR Team also performed footprinting for Alternatives 2 to 4 in the December 2010 Draft FFS, which are compared to Alternative 1:

- Alternative 2: Monitored Natural Attenuation (MNA)
- Alternative 3: P&T with Reinjection

- Alternative 4: Permeable Reactive Barrier (PRB)

These are discussed below, with supporting information provided in Appendices. SiteWise spreadsheet files are attached electronically.

2.3.1 Alternative 2 – MNA

Alternative 2 consists of maintaining the current landfill cap and shutting down the current P&T system. The layout of this alternative is illustrated on Figure 2-2. As per the particle tracks illustrated on Figure 2-2 (compared to Figure 2-1) this will eliminate capture of impacted water flowing beneath the landfill. The December 2010 Draft FFS assumes slightly more monitoring than in Alternative 1 ($150,000 per year versus $100,000 per year for the first 10 years, and $100,000 per year versus $75,000 per year for the subsequent 90 years). The alternative also includes some level of P&T plant decommissioning, though it was clarified on the Step 5 call that this would not involve building demolition. The capital costs included in the December 2010 Draft FFS also include "well installation" though the number of wells is not specified.

Table 2-3 summarizes the footprint results for Alternative 2 compared to the results for the baseline in Alternative 1. Input to the SiteWise tool and other supporting calculations for Alternative 2 are described in Appendix C-1. A cost spreadsheet is also included in Appendix C-1.

Table 2-3
Summary of Quantitative Footprint for Alternative 2 versus Alternative 1

GSR Parameter	Unit	Alternative 1 Value	Alternative 2 Value
Environmental			
Energy – Total	MMBtu	250,035	2,961
Energy – Direct Scope 1	MMBtu	45,546	1958
Energy – Indirect Scope 2	MMBtu	89,221	0
Energy – Indirect Scope 3	MMBtu	115,269	1003
% of Energy from Renewable Resources	%	6.0%	0%
Global warming potential	Metric tons CO2e	15,359	117
Global warming potential – Direct Scope 1	Metric tons CO2e	45	55
Global warming potential – Indirect Scope 2	Metric tons CO2e	5,461	0
Global warming potential – Indirect Scope 3	Metric tons CO2e	9,853	62
Criteria air pollutant emissions	Metric tons (NOx+SOx+PM)	22.3	0.6
Hazardous air pollutant emissions	Lb	negligible	negligible
Potable water use	1,000s of gallons	93,440	0
Other water use	1,000s of gallons	2,371,800	negligible
Refined materials use	Lbs	79,000	0
% of refined materials from recycled material	%	0%	N/A
Unrefined materials use	Ton	negligible	negligible
% of unrefined materials from recycled material	%	N/A	N/A
Non-hazardous waste generation	Ton	18,900	0
Hazardous waste generation	Ton	0	0

GSR Parameter	Unit	Alternative 1 Value	Alternative 2 Value
% of potential waste that is recycled or reused	%	0%	N/A
Land transferred or made available for beneficial use	Acres	0	0
Existing ecosystem destruction	Acres	0	0
Time frame for land reuse	Years	not clearly specified	not clearly specified
Flexibility and breadth of options for reuse	see below	not clearly specified	not clearly specified
Economic			
Life-cycle Cost, Discounted (2.7% discount rate)	$	$21.1 million	$4.2 million
Life-cycle Cost, Undiscounted	$	$62.2 million	$10.8 million
Up-front Cost	$	$0	$315,000
Societal			
Predicted number of injuries or fatalities for On-Site Worker	Number of injuries or fatalities	negligible	negligible
Predicted number of injuries or fatalities associated with transportation	Number of injuries or fatalities	1.2	0.06
One-Way Heavy Vehicle Trips through Res. Area	Trips	0	0

**Scale for flexibility and breadth of re-use options (greater GSR value with lower number, indicating more breadth and flexibility for potential re-use)*

1 - Unlimited re-use options
2 - Limited re-use options
3 - Only one re-use option

Primary Footprints That Would Improve

As would be expected, elimination of the P&T reduces or eliminates nearly all of the footprints, including the following:

- Energy use is nearly eliminated (reduced by more than 98%).
- Emissions of greenhouse gases are nearly eliminated (reduced by more than 99%).
- Emissions of criteria pollutants are reduced by more than 97%.
- Potable water use (for mixing chemicals) and other water use (extracted water discharged to the POTW and water associated with electricity production) are eliminated.
- Refined materials (treatment plant chemicals) are eliminated.
- Waste disposal for solids from the P&T system is eliminated.
- Life-cycle cost is reduced from $21.2 million to $4.2 million using discounting, and from $62.2 million to $10.8 million (without discounting).

- Risk of injury or fatality is nearly eliminated because the transportation of materials, personnel, and waste associated with O&M of the P&T system is eliminated.

The December 2010 Draft FFS does not differentiate between the various alternatives with respect to future land use considerations.

Primary Footprints That Would Worsen

There would be minor capital costs associated with decommissioning of the P&T system, and perhaps adding additional monitoring wells. Technically the percentage of energy from renewable energy would decline, but that is somewhat misleading because it is due to the complete elimination of electricity used for pumps, mixers, and building heat for which a small portion comes from renewable sources.

2.3.2 Alternative 3 – P&T with Reinjection

Alternative 3 consists of maintaining the current landfill cap and modifying the current P&T system to continue pumping at the two existing extraction wells, but modifying the treatment and discharge of the treated water. The layout of this alternative is illustrated on Figure 2-3. The December 2010 Draft FFS indicates that extracted groundwater would be run through a solids filtration media, such as a sand filter, to remove a percentage of the arsenic in groundwater (estimated between 20-40%), substantially eliminating much of the current treatment process. The solids filtration system would include methods for backwashing the filtration media to maintain filtration capacity and flow through the media. Filtered groundwater would then be injected into the landfill footprint, thus eliminating discharge to the POTW. Water would require chemical conditioning to remove oxygen prior to injection.

The December 2010 Draft FFS assumes the same level of monitoring as for Alternative 1 ($100,000 per year for the first 10 years, and $75,000 per year for the subsequent 90 years). The alternative also includes capital costs of $1.16 million for reinjection pilot testing, installation of injection wells plus piping, and treatment system modifications. Treatment plant replacement is assumed every 30 years at a cost of $750,000 each.

Table 2-4 summarizes the footprint results for Alternative 3 compared to the results for the baseline in Alternative 1. Input to the SiteWise tool and other supporting calculations for Alternative 3 are described in Appendix C-2. A cost spreadsheet is also included in Appendix C-2.

Table 2-4
Summary of Quantitative Footprint for Alternative 3 versus Alternative 1

GSR Parameter	Unit	Alternative 1 Value	Alternative 3 Value
Environmental			
Energy – Total	MMBtu	250,035	78,931
Energy – Direct Scope 1	MMBtu	45,546	25,303
Energy – Indirect Scope 2	MMBtu	89,221	47,918
Energy – Indirect Scope 3	MMBtu	115,269	5,710
% of Energy from Renewable Resources	%	6.0%	10.2%
Global warming potential – Total	Metric tons CO2e	15,359	4,423

GSR Parameter	Unit	Alternative 1 Value	Alternative 3 Value
Global warming potential – Direct Scope 1	Metric tons CO2e	45	52
Global warming potential – Indirect Scope 2	Metric tons CO2e	5,461	2,933
Global warming potential – Indirect Scope 3	Metric tons CO2e	9,853	1437
Criteria air pollutant emissions	Metric tons (NOx+SOx+PM)	22.3	11.1
Hazardous air pollutant emissions	Lb	negligible	negligible
Potable water use	1,000s of gallons	93,440	0
Other water use	1,000s of gallons	2,371,800	3,500
Refined materials use	Lbs	79,000	16,019
% of refined materials from recycled material	%	0%	0%
Unrefined materials use	Ton	negligible	negligible
% of unrefined materials from recycled material	%	N/A	N/A
Non-hazardous waste generation	Ton	18,900	5,400
Hazardous waste generation	Ton	0	0
% of potential waste that is recycled or reused	%	0%	N/A
Land transferred or made available for beneficial use	Acres	0	0
Existing ecosystem destruction	Acres	0	0
Time frame for land reuse	Years	not clearly specified	not clearly specified
Flexibility and breadth of options for reuse	see below	not clearly specified	not clearly specified
Economic			
Life-cycle Cost, Discounted (2.7% discount rate)	$	$21.1 million	$13.1 million
Life-cycle Cost, Undiscounted	$	$62.2 million	$36.2 million
Up-front Cost	$	$0	$1.2 million
Societal			
Predicted number of injuries or fatalities for On-Site Worker	Number of injuries or fatalities	negligible	0.27
Predicted number of injuries or fatalities associated with transportation	Number of injuries or fatalities	1.2	0.001
One-Way Heavy Vehicle Trips through Res. Area	Trips	0	0

**Scale for flexibility and breadth of re-use options (greater GSR value with lower number, indicating more breadth and flexibility for potential re-use)*

1 - Unlimited re-use options
2 - Limited re-use options
3 - Only one re-use option

Primary Footprints That Would Improve

By eliminating many components of the treatment system, a number of footprints are reduced or eliminated relative to Alternative 1 (i.e., the current system), including the following:

- Energy use is reduced by approximately 68%. This is due to reduced electricity usage (many pumps and mixers are eliminated), discontinued use of materials that require production and transport, and reduced amount of waste requiring transport. The percentage of energy from renewable energy would also increase, since a higher proportion of total energy use would come from electricity (some of which is from renewable sources).

- Emissions of greenhouse gases are reduced by approximately 71%, for many of the same reasons.

- Emissions of criteria pollutants are reduced by approximately 50%.

- Potable water use (for mixing chemicals) is eliminated. Also, the water that is extracted is placed back in the ground, so it is not really "used". In Alternative 1, water that is extracted is treated but not subsequently used, thus losing value as a potential resource. The remaining water use is the water estimated to be used for production of electricity used for system operation, which is lower than for Alternative 1 since less electricity is used in Alternative 3.

- Refined materials use is reduced by approximately 80%. Treatment plant chemicals are eliminated, but there is some addition of PVC and grout for the injection wells and HDPE for the piping to the injection wells.

- Waste disposal for solids from the P&T system is reduced by approximately 70%.

- Life-cycle cost is reduced from $21.2 million to $13.1 million using discounting, and from $62.2 million to $36.2 million (without discounting).

- Risk of injury or fatality is reduced because transportation of materials, personnel, and waste associated with O&M of the P&T system is reduced. There is a negligible addition of non-transportation risk added for equipment use associated with installation of injection wells and related piping.

The December 2010 Draft FFS does not differentiate between the various alternatives with respect to future land use considerations.

Primary Footprints That Would Worsen

There would be capital costs exceeding $1 million for installing injection wells and related piping.

Comparison of Alternative 3 to Alternative 2

Assuming Alternatives 2 and 3 are both determined to be protective (not evaluated part of this GSR evaluation), Alternative 2 has much lower footprints (and lower costs) than Alternative 3, and would be favored over Alternative 3 from a GSR perspective..

2.3.3 Alternative 4 – PRB

Alternative 4 includes installation of a permeable reactive barrier (PRB) at the north end of the landfill to replace the P&T system. A PRB is a passive in-situ treatment zone that contains reactive materials, oriented to intercept and remediate a contaminant plume. The PRB allows the passage of water while prohibiting the movement of contaminants by using media such as zero-valent metals, chelators, sorbents, and microbes. A continuous PRB is proposed as part of this alternative, which the December 2010 Draft FFS states would not require keying deep into the bedrock to prevent underflow because the natural flow regime would be largely maintained. The layout for this alternative is illustrated on Figure 2-4. In this alternative, treatment occurs in-situ as the particles pass through the wall.

The December 2010 Draft FFS assumes the same level of monitoring as for Alternative 1 ($100,000 per year for the first 10 years, and $75,000 per year for the subsequent 90 years). The alternative also includes capital costs of $12.78 million for wall installation and associated costs. A minor O&M cost of $15,000 per year is assumed and $40,000 is assumed to be required every 5 years for wall redevelopment (i.e. 20 events over 100 years).

Table 2-5 summarizes the footprint results for Alternative 4 compared to the results for the baseline in Alternative 1. Input to the SiteWise tool and other supporting calculations for Alternative 4 are described in Appendix C-3. A cost spreadsheet is also included in Appendix C-3.

Table 2-5
Summary of Quantitative Footprint for Alternative 4 versus Alternative 1

GSR Parameter	Unit	Alternative 1 Value	Alternative 4 Value
Environmental			
Energy – Total	MMBtu	250,035	49,009
Energy – Direct Scope 1	MMBtu	45,546	476
Energy – Indirect Scope 2	MMBtu	89,221	0
Energy – Indirect Scope 3	MMBtu	115,269	48,533
% of Energy from Renewable Resources	%	6.0%	0%
Global warming potential – Total	Metric tons CO2e	15,359	7,325
Global warming potential – Direct Scope 1	Metric tons CO2e	45	29
Global warming potential – Indirect Scope 2	Metric tons CO2e	5,461	0
Global warming potential – Indirect Scope 3	Metric tons CO2e	9,853	7296
Criteria air pollutant emissions	Metric tons (NOx+SOx+PM)	22.3	0.3
Hazardous air pollutant emissions	Lb	Negligible	negligible
Potable water use	1,000s of gallons	93,440	negligible
Other water use	1,000s of gallons	2,371,800	negligible
Refined materials use	Lbs	79,000	12,000,000
% of refined materials from recycled material	%	0%	0%
Unrefined materials use	Ton	Negligible	4,667
% of unrefined materials from recycled material	%	N/A	0%
Non-hazardous waste generation	Ton	18,900	0
Hazardous waste generation	Ton	0	0
% of potential waste that is recycled or reused	%	0%	N/A
Land transferred or made available for beneficial use	Acres	0	0
Existing ecosystem destruction	Acres	0	0
Time frame for land reuse	Years	not clearly specified	not clearly specified
Flexibility and breadth of options for reuse	see below	not clearly specified	not clearly specified
Economic			
Life-cycle Cost, Discounted (2.7% discount rate)	$	$21.1 million	$16.4 million

GSR Parameter	Unit	Alternative 1 Value	Alternative 4 Value
Life-cycle Cost, Undiscounted	$	$62.2 million	$22.8 million
Up-front Cost	$	$0	$12.8 million
Societal			
Predicted number of injuries or fatalities for On-Site Worker	Number of injuries or fatalities	Negligible	0.04
Predicted number of injuries or fatalities associated with transportation	Number of injuries or fatalities	1.2	0.07
One-Way Heavy Vehicle Trips through Res. Area	Trips	0	0

**Scale for flexibility and breadth of re-use options (greater GSR value with lower number, indicating more breadth and flexibility for potential re-use)*

1 - Unlimited re-use options
2 - Limited re-use options
3 - Only one re-use option

Primary Footprints That Would Improve

By eliminating the pump and treat system, a number of footprints are reduced or eliminated relative to Alternative 1 (i.e., the current system), including the following:

- Energy use is reduced by approximately 80%, due to elimination of pumps, motors, and heating. There would be one-time energy uses for the equipment associated with wall installation.

- Emissions of greenhouse gases are reduced by approximately 52%, for many of the same reasons.

- Emissions of criteria pollutants are nearly eliminated (reduced by approximately 99%).

- Water use is eliminated (except any minor use during wall construction).

- Waste disposal for solids from the P&T system is eliminated, and wastes for wall construction are kept on-site.

- Life-cycle cost is reduced from $21.2 million to $16.4 million using discounting, and from $62.2 million to $22.8 million (without discounting)

- Risk of injury or fatality is reduced because transportation of materials, personnel, and waste associated with O&M of the P&T system is reduced. There is a small amount of risk for transportation and for equipment use associated with installation of the wall.

The December 2010 Draft FFS does not differentiate between the various alternatives with respect to future land use considerations.

Primary Footprints That Would Worsen

Several of the footprints would increase, including the following:

- Refined materials usage is increased substantially, based on the iron used for the PRM (12,000,000 lbs).

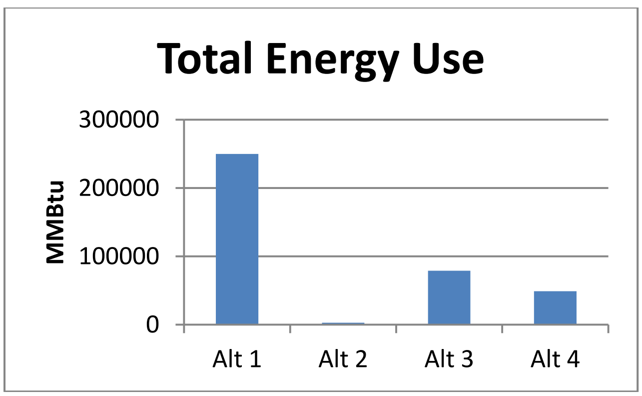
- Unrefined materials usage is increased substantially due to the sand used for the PRB (4,667 tons).

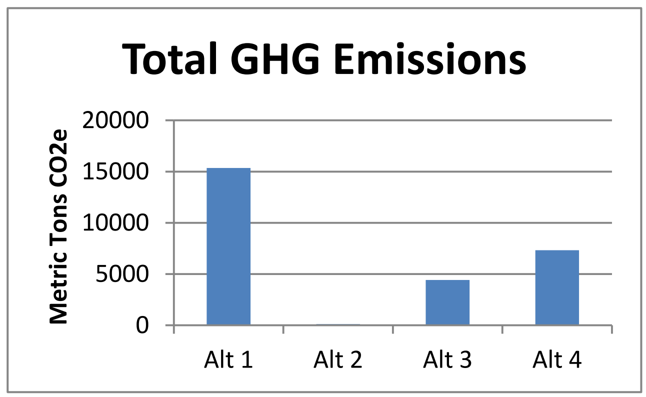
- There would be capital costs of approximately $12.8 million for wall construction and associated costs.

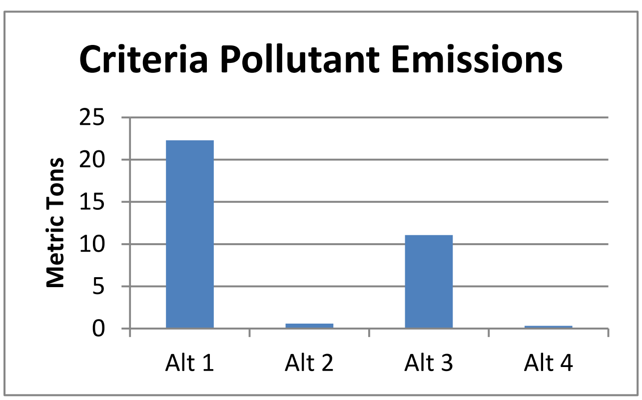
- Technically the percentage of energy from renewable energy would decline, but that is somewhat misleading because it is due to the complete elimination of electricity used for pumps, mixers, and building heat for which a small portion comes from renewable sources.

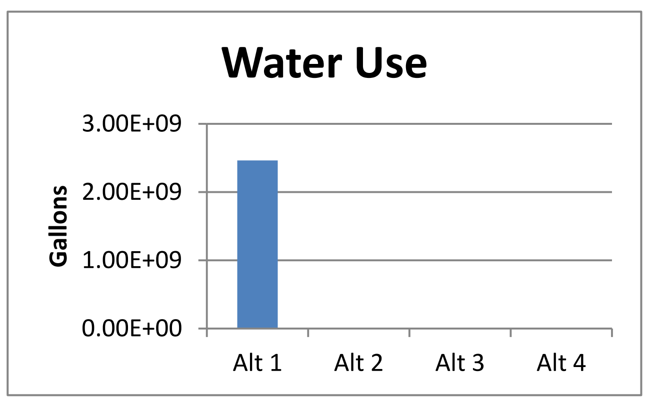
2.4 COMPARISON OF KEY FOOTPRINTS FOR ALTERNATIVES 1 THROUGH 4

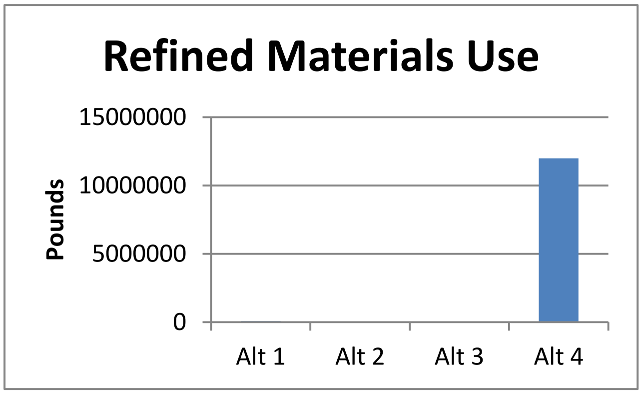
The charts below illustrate the values for some of the key footprints calculated for Alternatives 1 through 4 in the December 2010 Draft FFS.

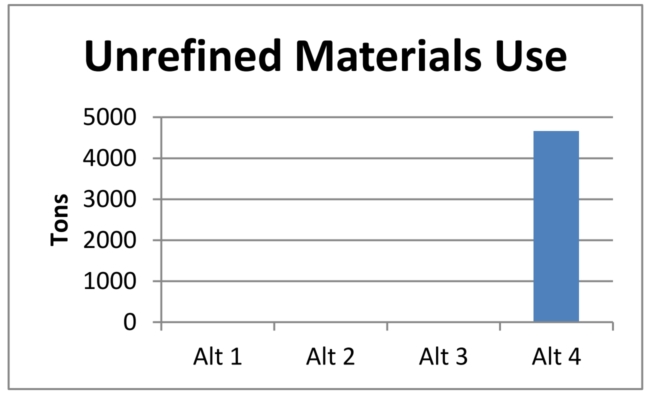


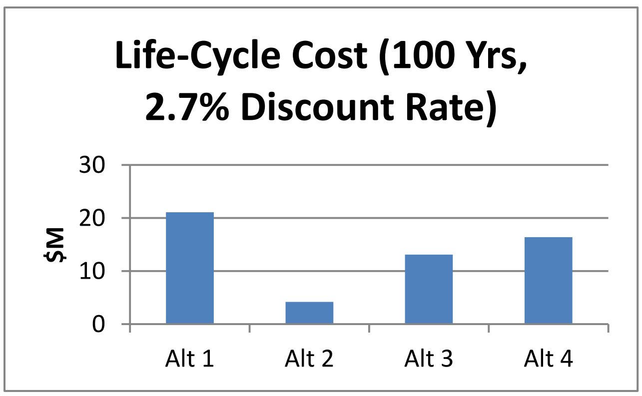


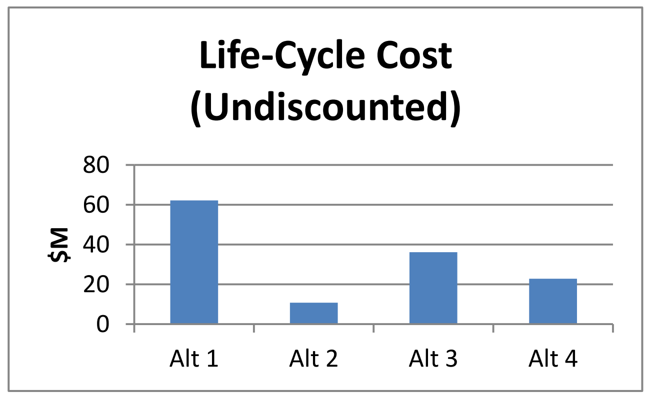


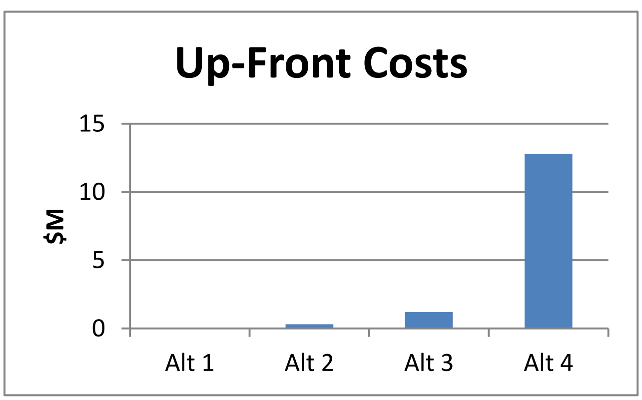


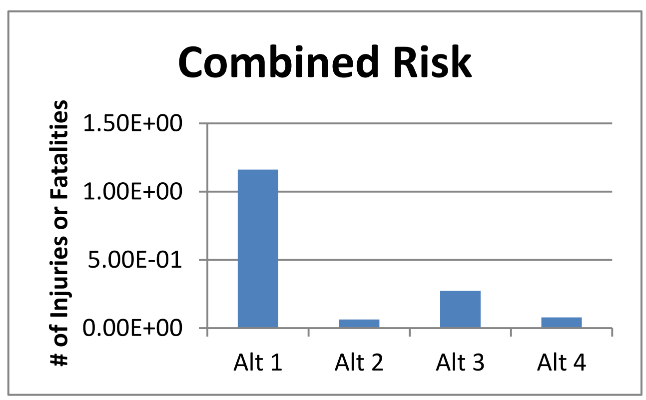












In general, Alternative 1 (current P&T system) has higher footrpints (including life-cycle costs) than the other alternatives. An exception is materials use, which is higher for Alternative 4. Note that this GSR evaluation does not in any manner include an evaluation or judgment of the protectiveness of any of the alternatives described in the December 2010 Draft FFS.

2.5 FOOTPRINTING FOR ALTERNATIVES A AND B (RED COVE)

The GSR Team also performed footprinting for the following alternatives in the December 2010 Draft FFS intended to address groundwater flux to Red Cove:

- Alternative A: Barrier Wall/PRB
- Alternative B: Barrier Wall

These alternatives both include barrier walls, but differ in the type of wall. In Alternative A, illustrated in Figure 2-5, a relatively impermeable slurry wall would be installed between the landfill and Red Cove, and a section of the wall would be filled with zero-valent iron (ZVI) to create a PRB to reduce arsenic concentrations in groundwater flowing into the pond. In Alternative B, illustrated in Figure 2-6, a relatively impermeable slurry wall would be installed between the landfill and Red Cove, but without a PRB.

For Alternative A, the December 2010 Draft FFS estimated capital cost of $2.35 million, minor annual O&M cost of $5,000 per year, wall redevelopment every 5 years at $25,000 per event (i.e. 20 events over 100 years) and a one-time PRM replacement at $1 million. For Alternative B, the December 2010 Draft FFS estimated capital cost of $1.21 million, and minor annual O&M cost of $5,000 per year.

Table 2-6 summarizes the footprint results for Alternative A compared to Alternative B for Red Cove. Input to the SiteWise tool and other supporting calculations for Alternative A, and a cost spreadsheet for Alternative A, are included in Appendix C-4. Input to the SiteWise tool and other supporting calculations for Alternative B, and a cost spreadsheet for Alternative B, are included in Appendix C-5.

Table 2-6
Summary of Quantitative Footprint for Alternative A versus Alternative B

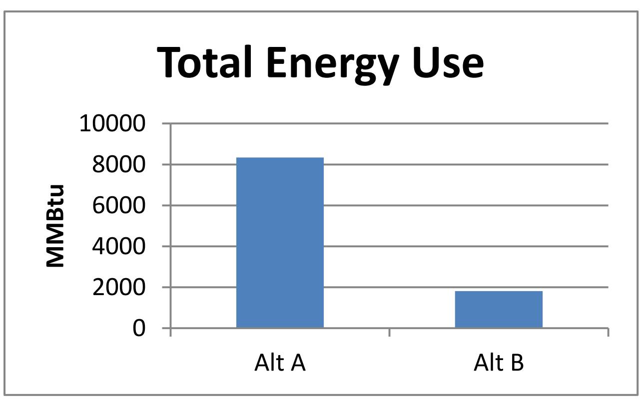
GSR Parameter	Unit	Alternative A Value	Alternative B Value
Environmental			
Energy – Total	MMBtu	8,336	1,816
Energy – Direct Scope 1	MMBtu	199	164
Energy – Indirect Scope 2	MMBtu	0	0
Energy – Indirect Scope 3	MMBtu	8136	1652
% of Energy from Renewable Resources	%	0%	0%
Global warming potential – Total	Metric tons CO2e	1,737	109
Global warming potential – Direct Scope 1	Metric tons CO2e	12	10
Global warming potential – Indirect Scope 2	Metric tons CO2e	0	0
Global warming potential – Indirect Scope 3	Metric tons CO2e	1,725	99
Criteria air pollutant emissions	Metric tons (NOx+SOx+PM)	0.1	0.1
Hazardous air pollutant emissions	Lb	Negligible	negligible
Potable water use	1,000s of gallons	negligible	negligible
Other water use	1,000s of gallons	Negligible	negligible
Refined materials use	Lbs	1,666,000	0
% of refined materials from recycled material	%	0%	N/A
Unrefined materials use	Ton	6,551	6,597
% of unrefined materials from recycled	%	N/A	N/A

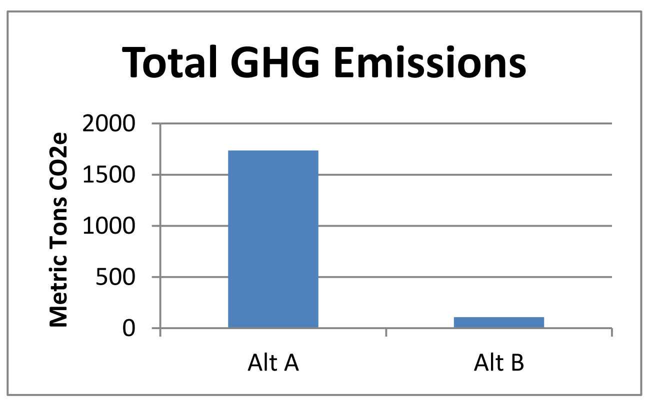
GSR Parameter	Unit	Alternative A Value	Alternative B Value
material			
Non-hazardous waste generation	Ton	0	0
Hazardous waste generation	Ton	N/A	N/A
% of potential waste that is recycled or reused	%	0%	N/A
Land transferred for beneficial use	Acres	0	0
Existing ecosystem destruction	Acres	0	0
Time frame for land reuse	Years	not clearly specified	not clearly specified
Flexibility and breadth of options for reuse	see below	not clearly specified	not clearly specified
Economic			
Life-cycle Cost, Discounted (2.7% discount rate)	$	$3.3 million	$1.4 million
Life-cycle Cost, Undiscounted	$	$5.4 million	$1.7 million
Up-front Cost	$	$2.4 million	$1.2 million
Societal			
Predicted number of injuries or fatalities for On-Site Worker	Number of injuries or fatalities	0.005	0.004
Predicted number of injuries or fatalities associated with transportation	Number of injuries or fatalities	0.002	0.002
One-Way Heavy Vehicle Trips through Res. Area	Trips	0	0

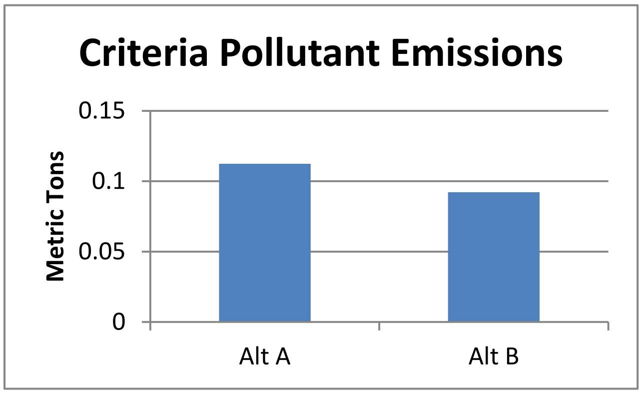
**Scale for flexibility and breadth of re-use options (greater GSR value with lower number, indicating more breadth and flexibility for potential re-use)*

1 - Unlimited re-use options
2 - Limited re-use options
3 - Only one re-use option

The charts below illustrate the values for some of the key footprints calculated for Alternatives A and B in the December 2010 Draft FFS.






Criteria Pollutant Emissions
Metric Tons
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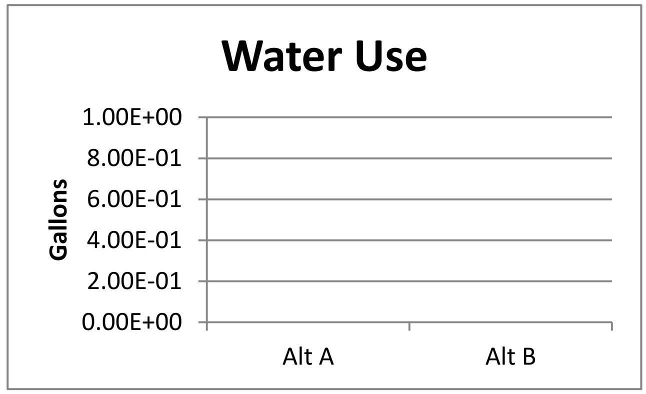
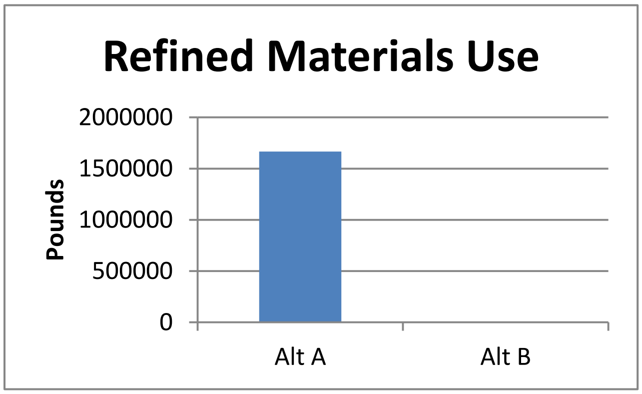
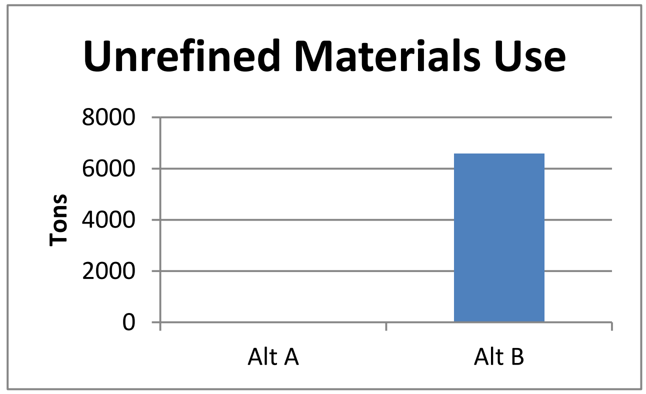
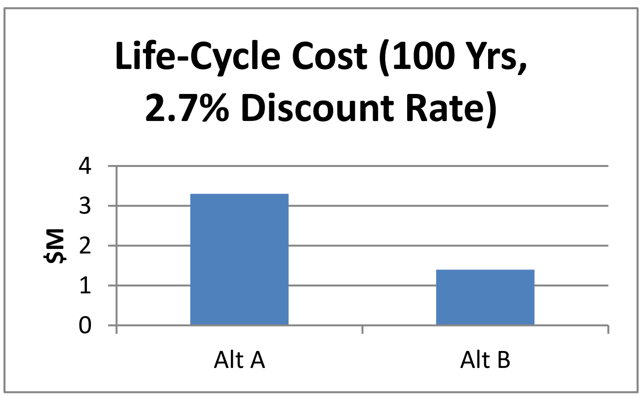
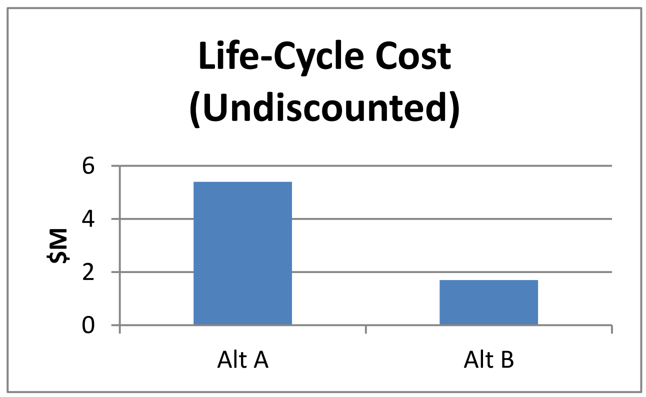
0.1
0.05
0
Alt A
Alt B

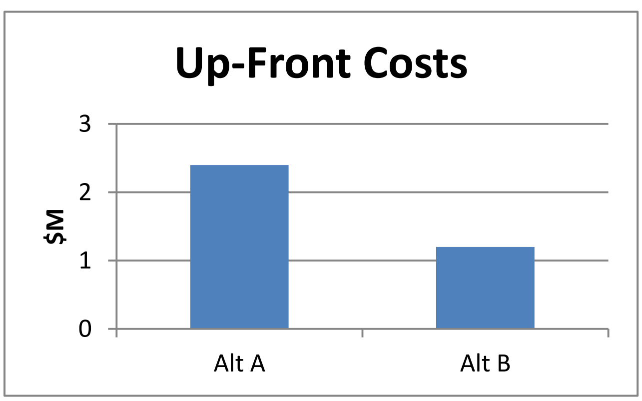

Water Use
Gallons
1.00E+00
8.00E-01
6.00E-01
4.00E-01
2.00E-01
0.00E+00
Alt A
Alt B

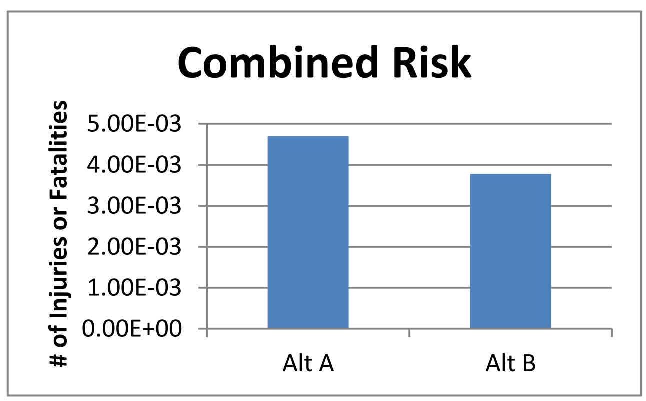

Refined Materials Use
Pounds
2000000
1500000
1000000
500000
0
Alt A
Alt B


Unrefined Materials Use
Tons
8000
6000
4000
2000
0
Alt A
Alt B


Life-Cycle Cost (100 Yrs, 2.7% Discount Rate)
$M
4
3
2
1
0
Alt A
Alt B


Life-Cycle Cost (Undiscounted)
$M
6
4
2
0
Alt A
Alt B


Up-Front Costs
$M
3
2
1
0
Alt A
Alt B


Combined Risk
# of Injuries or Fatalities
5.00E-03
4.00E-03
3.00E-03
2.00E-03
1.00E-03
0.00E+00
Alt A
Alt B

In general, Alternative B has lower footprints than Alternative A, primarily because no iron is required for the wall (the production of the iron is the major use of energy and major source of greenhouse gases in Alternative A). Alternative A also uses refined materials (iron) not needed in Alternative B. Alternative A has higher life-cycle costs (discounted and non-discounted) and higher capital costs. Safety risks are similar (very low) for both alternatives. Note that this GSR evaluation does not in any manner include an evaluation or judgment of the protectiveness of any of the alternatives described in the December 2010 Draft FFS.

2.6 OTHER QUALITATIVE CONSIDERATIONS

As stated earlier, this GSR evaluation pertains to the Draft FFS phase and does not in any manner include an evaluation or judgment of the protectiveness of any of the alternatives described in the December 2010 Draft FFS. It is intended that this GSR evaluation in the "Draft FFS phase" will serve as a secondary decision factor in alternative selection (i.e., not part of primary decision criteria associated with remedy selection). Because this GSR evaluation has been performed during the Draft FFS phase, the focus is to present and compare GSR aspects of the various alternatives. After a remedy is selected, a more detailed GSR evaluation regarding design aspects of the selected alternative can be performed, perhaps between the 30 percent and 60 percent design.

3.0 GSR RECOMMENDATIONS

These are recommendations provided by the GSR Team for the consideration of the Project Team, and potentially other project stakeholders. These are not requirements, and implementation should ultimately be decided by the Project Team based on their concurrence regarding GSR benefits and/or other project-specific constraints.

This GSR report is performed during the Draft FFS phase, and the primary focus is to provide GSR footprinting for alternatives in the December 2010 Draft FFS. As such, recommendations are limited. After a remedy is selected, a more detailed GSR evaluation with recommendations regarding design aspects of the selected alternative can be performed, perhaps between the 30 percent and 60 percent design.

GSR recommendations are summarized in the form of tracking tables, as follows:

Table Number	Recommendation
3-1	3.1 - Address Potential for Land Reuse in Final FFS
3-2	3.2 - Eliminate Building Heater in Alternatives 1 and 3 with Heat Exchange from Extracted Water
3-3	3.3 - Submit Report Appendices and Lab Reports on CD

The tracking table format allows the implementation status of the recommendation to be updated as the project progresses.

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Table 3-1
Tracking Table for Recommendation 3.1

<table>
<tr><td colspan="2" rowspan="2">Recommendation:

3.1 - Address Potential for Land Reuse in Final FFS</td><td>Current Date:
3/4/11</td></tr>
<tr><td>Date of Original Recommendation:
3/4/11</td></tr>
<tr><td colspan="3">Basis for Recommendation (Include discussion of cost impacts and value if appropriate):

The December 2010 Draft FFS does not address potential future uses of the landfill area, and it is recommended that such potential uses be considered in the Final FFS.</td></tr>
<tr><td colspan="3">Resources Conserved:
☐ Hazardous air pollutants ☐ GHG emissions (CO2e) ☐ Energy ☐ Water ☐ Waste
☐ Criteria pollutants ☐ Safety/Community ☐ Materials ☒ Land-use</td></tr>
<tr><td>Qualitative Net Cost Impact Over 5 Years, No Discounting

☐ Cost Increase ☐ Cost Savings
☐ Cost Neutral ☒ N/A</td><td colspan="2">☐ Recommended action otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="3">Attachment(s) to report with footprint assumptions and calculations:

Not applicable.</td></tr>
<tr><td>Implementation Status:

☐ Fully
☐ Partially
☒ Not Yet
☐ Not Planned</td><td colspan="2">Explanation of Status:

This is a new recommendation for the Project Team to consider for the Final FFS.</td></tr>
</table>

Table 3-2
Tracking Table for Recommendation 3.2

<table>
<tr><td colspan="3">Recommendation:

3.2 Eliminate Building Heater in Alternatives 1 and 3 with Heat Exchange from Extracted Water</td><td>Current Date:
3/4/11
Date of Original Recommendation:
3/4/11</td></tr>
<tr><td colspan="4">Basis for Recommendation (Include discussion of cost impacts and value if appropriate):

A heat exchanger could be used in Alternatives 1 and 3, as discussed in Section 5.5.1 of the RSE. That analysis suggested a capital cost in the order of $15,000, net savings of $4,500 per year due to offset electrical usage (i.e., payback in less than 4 years), and reductions in energy use, GHG emissions, etc. Based on the footprinting for Alternative 1 (see Section 2.2.2 of this report), the electricity for the building heater represents 28% of the electricity use for the existing system. This portion of the footprint could be eliminated by assuming that a heat exchanger will be implemented, and this change could be assumed within the Final FFS.</td></tr>
<tr><td colspan="4">Resources Conserved:
☐ Hazardous air pollutants ☒ GHG emissions (CO2e) ☒ Energy ☐ Water ☐ Waste
☒ Criteria pollutants ☐ Safety/Community ☐ Materials ☐ Land-use</td></tr>
<tr><td colspan="2">Qualitative Net Cost Impact Over 5 Years, No Discounting

☐ Cost Increase ☒ Cost Savings
☐ Cost Neutral ☐ N/A</td><td colspan="2">☐ Recommended action otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☒ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="4">Attachment(s) to report with footprint assumptions and calculations:

Not rigorously calculated in this report. See Section 5.1.1 of the RSE report.</td></tr>
<tr><td>Implementation Status:

☐ Fully
☐ Partially
☒ Not Yet
☐ Not Planned</td><td colspan="3">Explanation of Status:

This is a new recommendation for the Project Team to consider for the Final FFS.</td></tr>
</table>

Table 3-3
Tracking Table for Recommendation 3.3

Recommendation: *3.3 - Submit Report Appendices and Lab Reports on CD*	Current Date: 3/4/11 Date of Original Recommendation: 3/4/11
Basis for Recommendation (Include discussion of cost impacts and value if appropriate): *During discussion of BMPs during the Step 5 call, it was noted that the annual report for this project is distributed in both hard copy and electronic forms. The distribution list is periodically updated to indicate which recipients require hard copies and which prefer electronic copies only. The current policy is to only print hard copies of text, figures, and tables, but there are times when appendices and lab data are also printed hard copy. The GSR Team suggested that lab data and other appendices be distributed on disk instead of hard copies, and the Project Team agreed that this would be a good practice. This will save on paper, shipping weight, storage space, etc.*	
Resources Conserved: ☒ Hazardous air pollutants ☒ GHG emissions (CO2e) ☒ Energy ☒ Water ☒ Waste ☒ Criteria pollutants ☐ Safety/Community ☒ Materials ☐ Land-use	
Qualitative Net Cost Impact Over 5 Years, No Discounting ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A	☐ Recommended action otherwise required? If checked, required by:
Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000	
Attachment(s) to report with footprint assumptions and calculations: *No detailed footprinting performed for this recommendation.*	
Implementation Status: ☐ Fully ☒ Partially ☐ Not Yet ☐ Not Planned	Explanation of Status: *This is a new recommendation for the Project Team to consider. This has already been partially implemented by the Project Team in past reports.*

FIGURES

Figure 1-1: Site Locus (From Figure 1 of December 2010 Draft FFS by Sovereign Consulting)

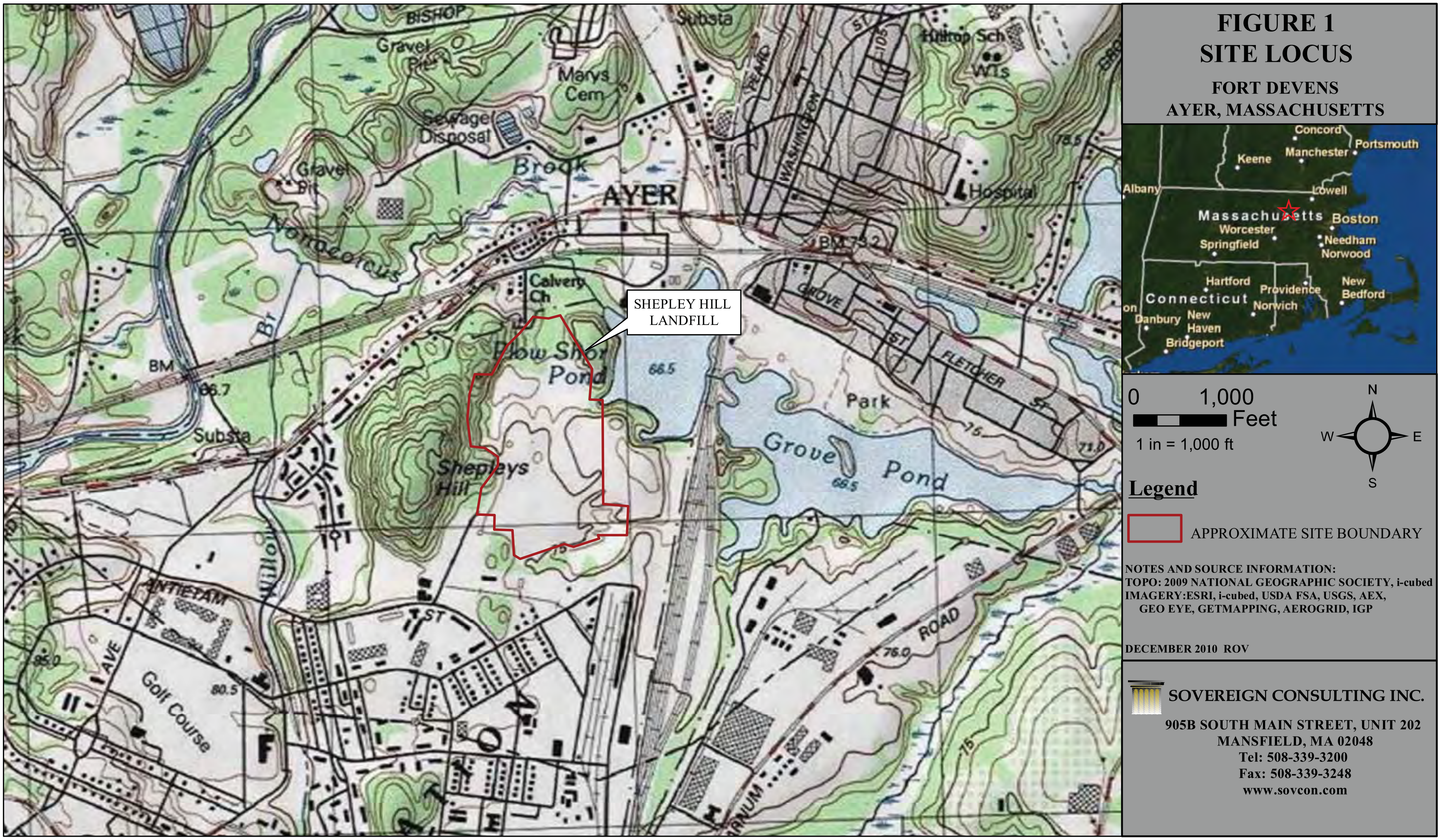
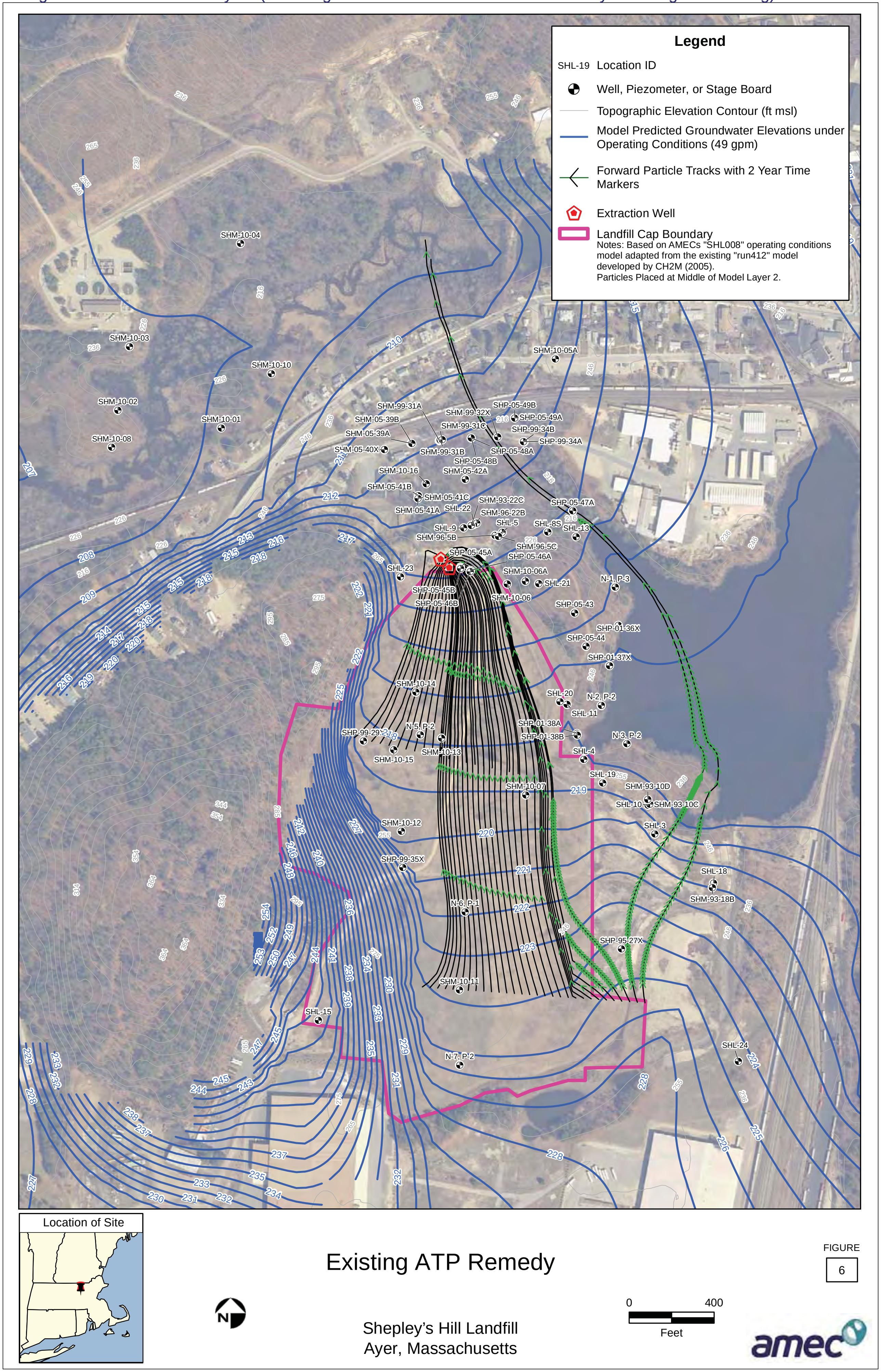


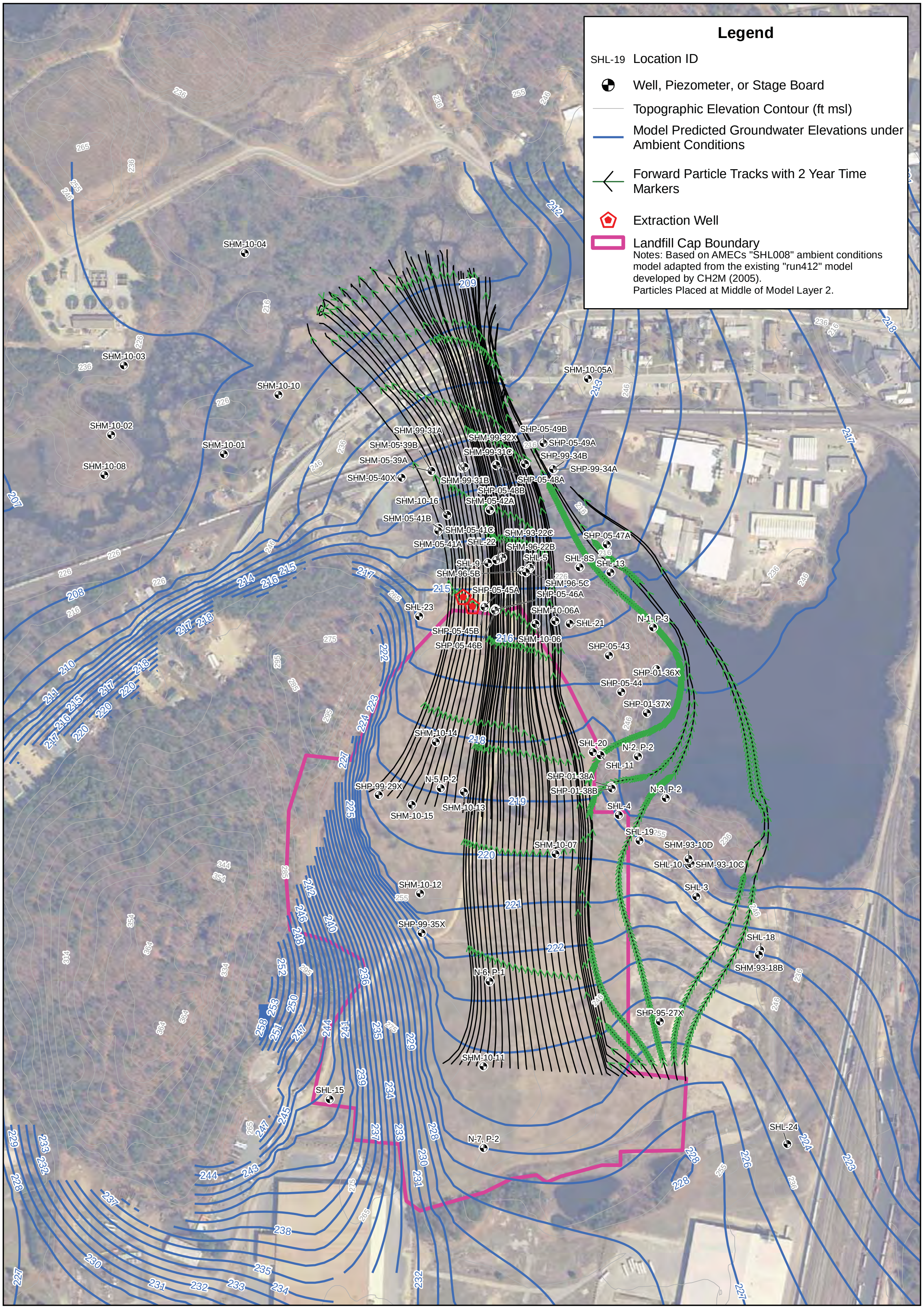
Figure 2-1: Alternative 1 Layout (From Figure 6 of December 2010 Draft FFS by Sovereign Consulting)



H:\ShepleyLandfill\Task37\MXD\Fig6_ExistingATPRemedy.mxd December 22, 2010 DWN: JDP APC CHKD: AKN

Aerial Imagery: 1:5,000 Color Digital Ortho Images, Mass GIS, 2005.

Figure 2-2: Alternative 2 Layout (From Figure 7 of December 2010 Draft FFS by Sovereign Consulting)



Location of Site

Forward Particle Tracks without ATP Extraction (MNA)

FIGURE

7

0 400

Feet

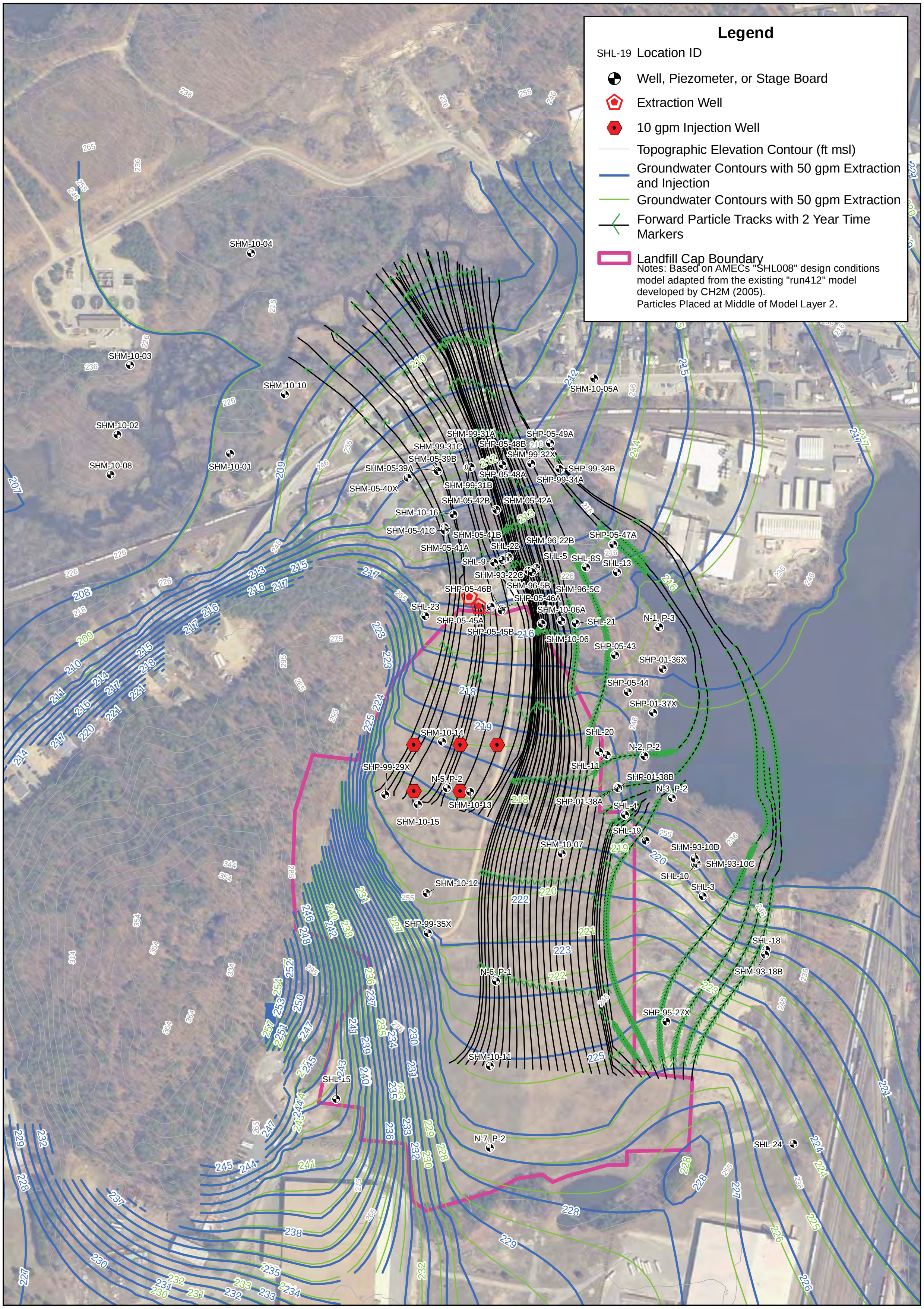
Shepley's Hill Landfill
Ayer, Massachusetts

amec

H:\ShepleyLandfill\Task37\MXD\Fig7_FPTwithoutATPExtraction.mxd December 22, 2010 DWN: JDP APC CHKD: AKN

Aerial Imagery: 1:5,000 Color Digital Ortho Images, Mass GIS, 2005.

Figure 2-3: Alternative 3 Layout (From Figure 8 of December 2010 Draft FFS by Sovereign Consulting)



Location of Site

Groundwater Recirculation System with Injection Wells

FIGURE

8

0 400

Feet

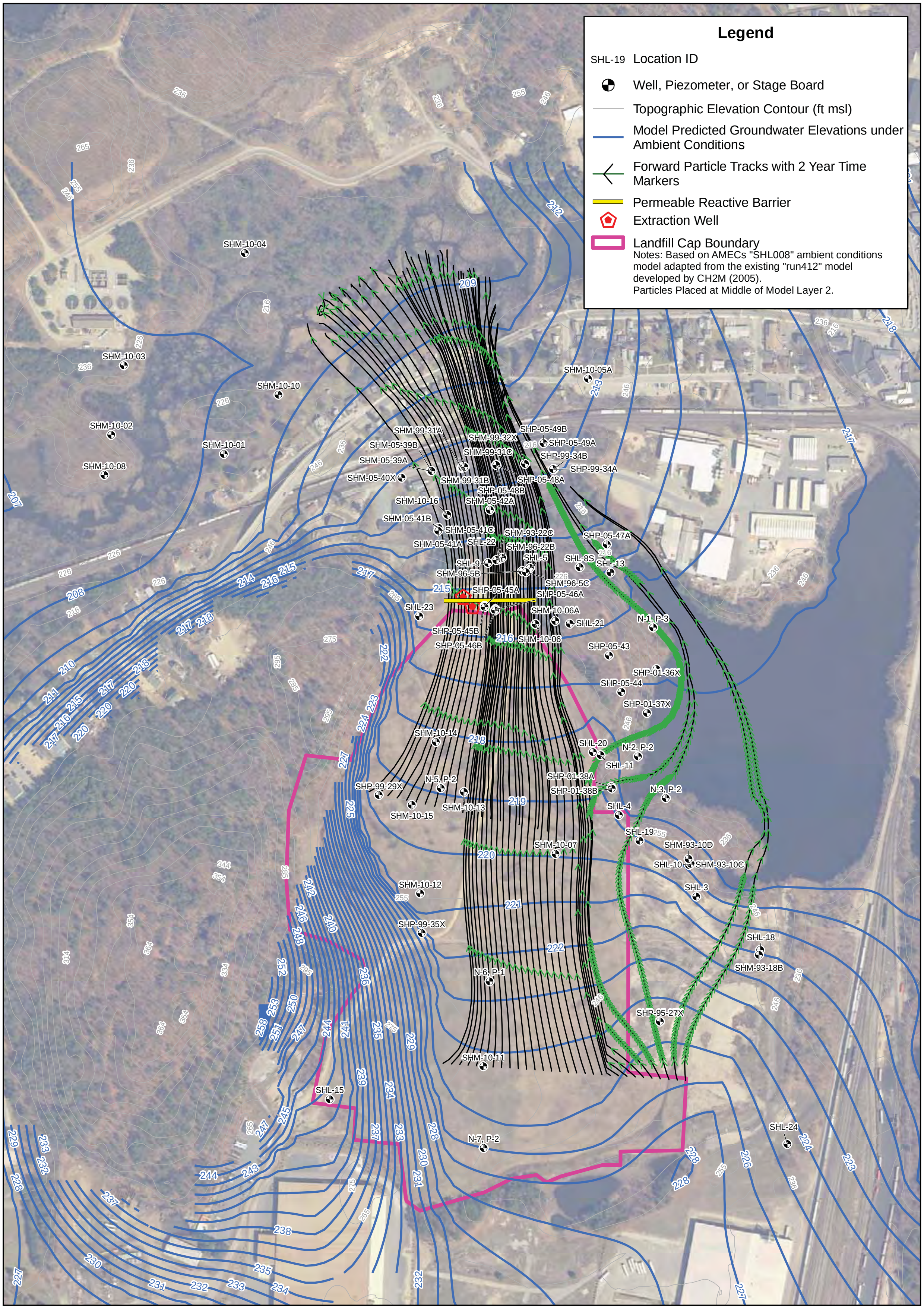
Shepley's Hill Landfill
Ayer, Massachusetts

amec

H:\ShepleyLandfill\Task37\MXD\Fig8_GroundwaterRecirculationSystemwInjWells.mxd December 22, 2010 DWN: JDP APC CHKD: AKN

Aerial Imagery: 1:5,000 Color Digital Ortho Images, Mass GIS, 2005.

Figure 2-4: Alternative 4 Layout (From Figure 9 of December 2010 Draft FFS by Sovereign Consulting)



Location of Site

Permeable Reactive Barrier North of SHL

FIGURE

9

0 400

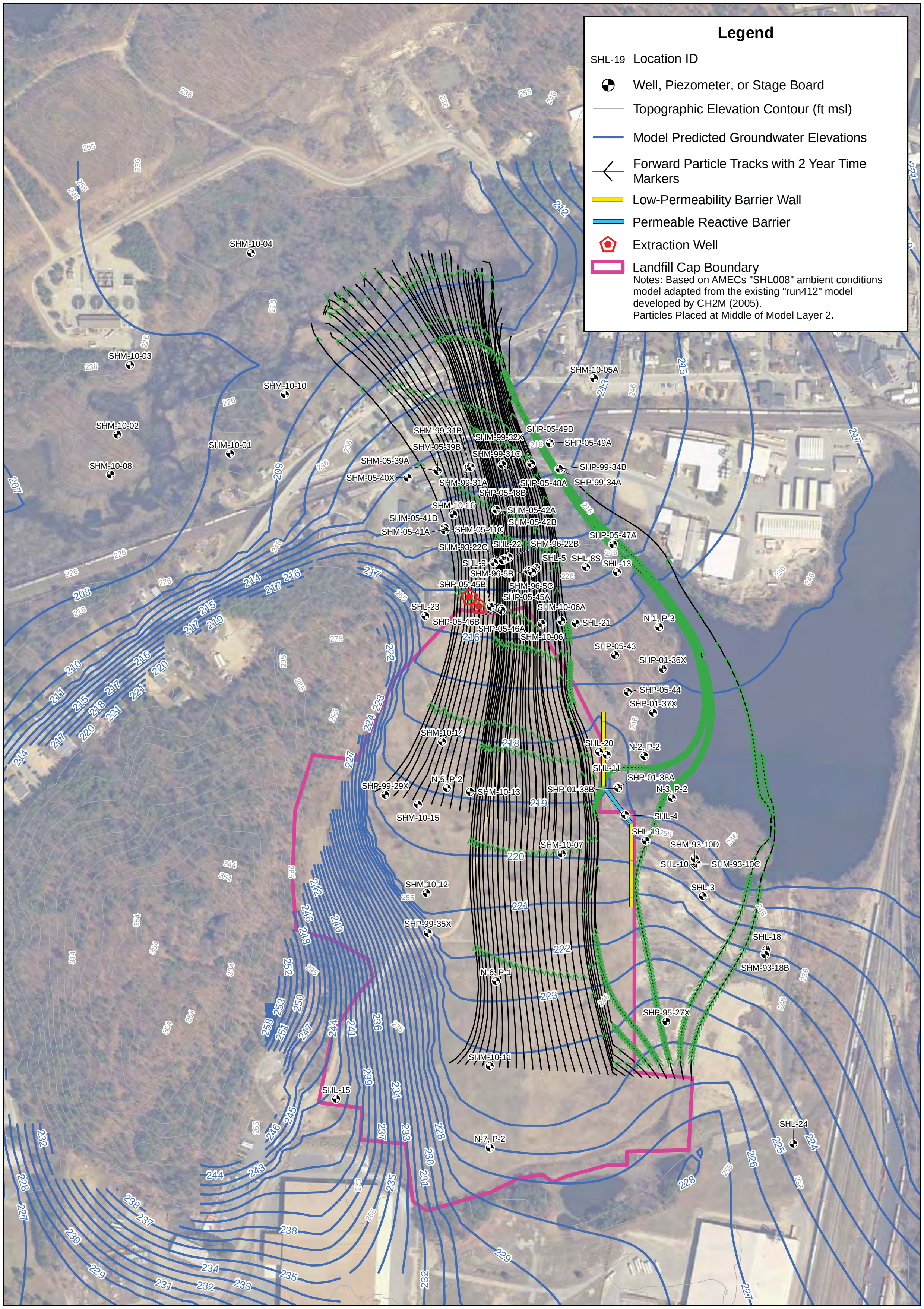
Feet

Shepley's Hill Landfill

Ayer, Massachusetts

amec

Figure 2-5 Alternative A Layout (From Figure 12 of December 2010 Draft FFS by Sovereign Consulting)



Location of Site

Containment Wall with Permeable Reactive Barrier East of SHL

Shepley's Hill Landfill
Ayer, Massachusetts

0 400
Feet

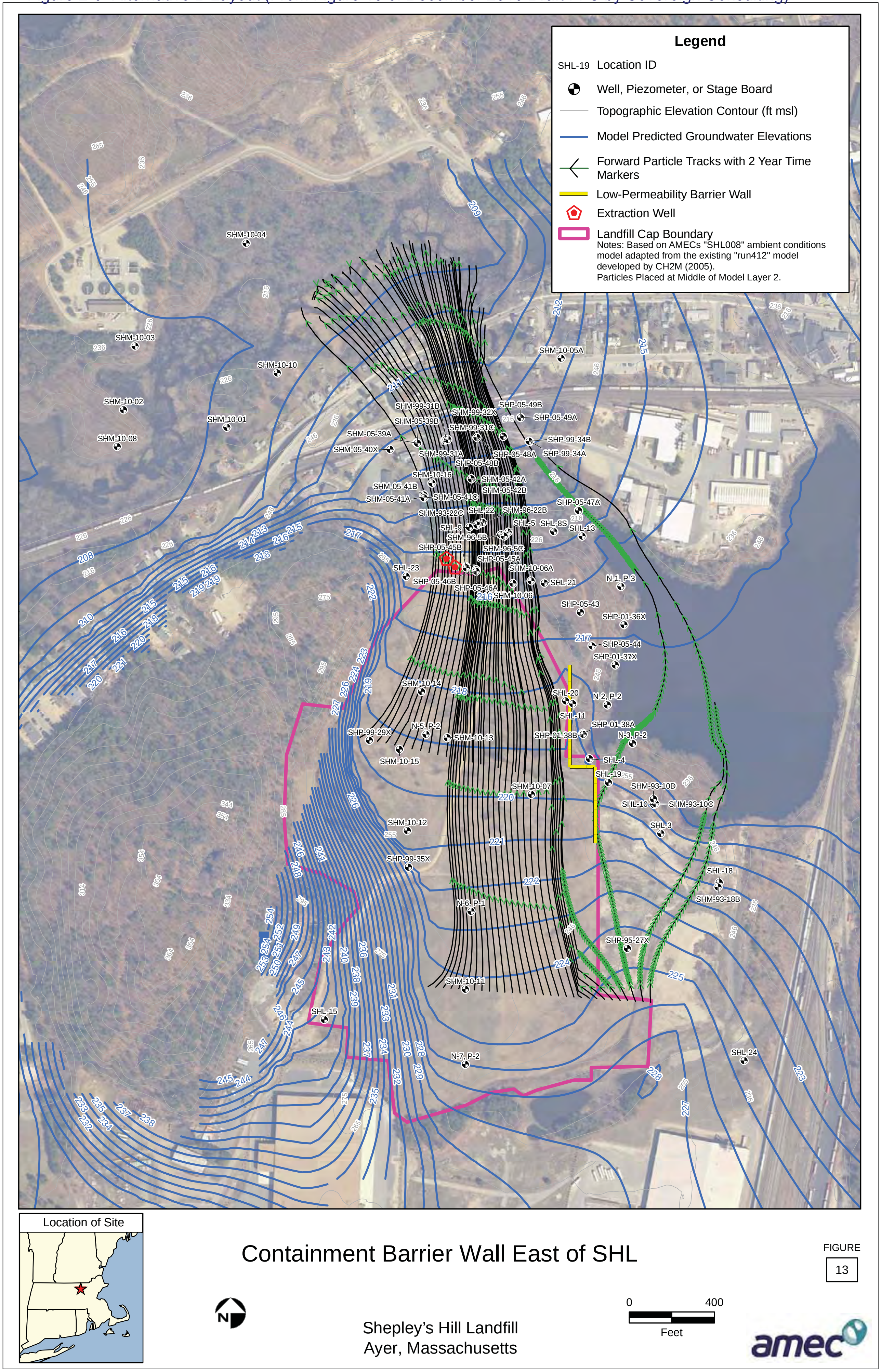
FIGURE
12

amec

H:\ShepleyLandfill\Task37\MXD\Fig12_ContainmentWallwithPermeableReactiveBarrier.mxd December 22, 2010 DWN: JDP APC CHKD: AKN

Aerial Imagery: 1:5,000 Color Digital Ortho Images, Mass GIS, 2005.

Figure 2-6 Alternative B Layout (From Figure 13 of December 2010 Draft FFS by Sovereign Consulting)



H:\ShepleyLandfill\Task37\MXD\Fig13_ContainmentBarrierWalll.mxd December 22, 2010 DWN: JDP APC CHKD: AKN

Aerial Imagery: 1:5,000 Color Digital Ortho Images, Mass GIS, 2005.

APPENDIX A

Best Management Practice (BMP) Tables

BMP Category A: Planning

BMP A-1: Develop a culture of GSR within the Project Team and encourage GSR ideas from project staff	**Date:** 3/2/11 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☒ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☒ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

The Project Team's participation in this Study indicates an interest in GSR considerations. There is also a section regarding energy use in the December 2010 Draft FFS. The Project Team indicated that this will be a greater consideration after the current remedy selection process is completed. It was noted that the current contractor is tasked with optimization, but that is primarily cost driven, so to the extent GSR considerations correlate with cost there would be some benefits. The Project Team indicated that investments in GSR are not likely to occur if the payback period is greater than 5 years.

BMP A-2: Incorporate a section on GSR in project meetings, work plans, and reports	**Date:** 3/2/11 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☒ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☐ Waste ☒ Criteria pollutants ☒ Materials ☐ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

The December 2010 Draft FFS lists GSR practices as a secondary criterion for remedy selection, but no other reports to date have specifically addressed GSR as its own section. The 2009 RSE, performed by USEPA, did include a substantial GSR component.

BMP Category A: Planning

BMP A-3: Identify and periodically update a list of key stakeholders and their concerns with respect to GSR considerations	**Date:** 3/2/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < \$10,000 ☐ \$10,001 - \$50,000 ☐ \$50,001 - \$100,000 ☐ \$100,001 - \$500,000 ☐ > \$500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☒ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Such a list does not exist at the time of this evaluation. The Project Team is aware of overall concerns of RAB members. However, the Project Team believes that engaging other Stakeholders specifically regarding GSR concerns may lead to more difficulties than benefits.

BMP A-4: Schedule activities for appropriate seasons and/or time of day to reduce delays caused by weather conditions and fuel needed for heating or cooling Examples: - Work at night in summer to avoid heat stress - Perform field activities in summer to take advantage of longer daylight	**Date:** 3/2/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < \$10,000 ☐ \$10,001 - \$50,000 ☐ \$50,001 - \$100,000 ☐ \$100,001 - \$500,000 ☐ > \$500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

It is too early in the process for this BMP to be applied, but it should be considered during design and construction.

BMP Category A: Planning

BMP A-5: Prepare, store, and distribute documents electronically	**Date:** 3/2/11 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☒ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☐ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

The annual report for this project is distributed in both hard copy and electronic forms. The distribution list is periodically updated to indicate which recipients require hard copies and which prefer electronic copies only.

The current policy is to only print hard copies of text, figures, and tables, but there are times when appendices and lab data are also printed hard copy. The GSR Team suggested that lab data and other appendices be distributed on disk instead of hard copies, and the Project Team agreed that this would be a good practice.

BMP A-6: Utilize teleconferences rather than meetings when feasible	**Date:** 3/2/11 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Teleconferencing is utilized as much as possible. Quarterly meetings with the RAB and monthly meetings with the BRAC Closure Team (BCT) are conducted in person, and the Project Team stated that those in-person meetings are appropriate. For the BCT meeting, some participants travel from a significant distance (ex: California, New Jersey).

BMP A-7: Incorporate green specifications into solicitations and contracts Examples: - Follow pertinent green procurement policies - Select hotel chains with "green" policies - Select laboratories that utilize renewable energy		**Date:** 3/2/11 ☒ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A	
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☒ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000	
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:	
Notes (including discussion of possible value of implementing the BMP): *This BMP is potentially applicable for the future contracting, but has not been fully considered. Due to the current performance-based contract, low cost is prioritized over GSR considerations. The current contract does contain an optimization clause. In addition, a "buy American" specification is part of the overall base contract, and that is also an important consideration.*		

BMP A-8: Integrate schedules to allow for resource sharing and fewer days of field mobilization		**Date:** 3/2/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A	
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000	
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☐ Waste ☒ Criteria pollutants ☐ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:	
Notes (including discussion of possible value of implementing the BMP): *It is too early in the process for this BMP to be applied, but it should be considered during construction.*		

BMP A-9: Explore multiple site reuse options, including those that include some restriction of site reuse and related resource conservation	**Date:** 3/2/11 ☐ Applicable ☐ Evaluated ☐ Practical

Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☒ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Site reuse is not addressed in the December 2010 Draft FFS and is not a stated part of the remedy. However, some people have expressed interest in potential use of the landfill.

ICs and LUCs are a component of all remedy alternatives that are being considered. Even the most aggressive remedy leaves restricted use and ICs, due in part to high background levels.

BMP A-10: Conduct thorough review of project documents and historical records to minimize required scope of investigation Examples: - IRP projects: determine if there are previous aquifer tests that can be used for groundwater modeling rather than conducting new aquifer tests - MMRP projects: perform careful review of historic documents, aerial photographs, and other existing information to reduce the footprint of land that needs to be disturbed for thorough investigation and remediation - MMRP projects: use IRP sampling data to supplement and enhance the MMRP field program (if available)	**Date:** 3/2/11 ☒ Applicable ☒ Evaluated ☒ Practical

Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Historical information going back decades has been incorporated into the CSM so that current efforts can be limited to filling gaps in existing data. Data from previous models has also been used to update the current groundwater model.

BMP Category B: Characterization and/or Remedy Approach

BMP B-1: Develop and routinely update a conceptual site model (CSM) to use as a basis for making remedial process decisions	**Date:** 3/2/11 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☒ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

A great deal of effort has already been made in updating the CSM as a basis for remedy decisions. The cost and up-front investment regarding GSR are hard to quantify.

BMP B-2: Perform frequent optimization evaluations to improve efficiency of current or planned actions and/or develop alternative remedial approaches that might shorten remedy duration or otherwise improve the net environmental benefit of the remedy	**Date:** 3/2/11 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☒ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☒ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Optimization is already a part of the O&M contract, and the December 2010 Draft FFS is part of an effort to optimize the long-term remedy. The up-front investment regarding GSR is hard to quantify. An RSE for this site was also conducted recently by USEPA, but implementation of recommendations is generally pending the current remedy selection decision.

BMP Category B: Characterization and/or Remedy Approach

<table>
<tr><td colspan="3">BMP B-3: Use appropriate characterization or remedy approach based on site conditions
Examples:
- Consider in-situ and passive remedy options that offer adequate protectiveness
- Consider in-situ bioremediation if conditions are already anaerobic and constituents are conducive to reductive dechlorination
- Compare source removal versus in-situ and ex-situ remedial options
- Consider different technologies for impacted areas with higher and lower concentrations
- Use realistic times to remedy closeout (i.e., estimations through modeling) rather than assumed remedy timeframes (e.g., 30 years), which is often used for evaluation of FS alternatives
- MMRP projects: evaluate man-portable DGM instruments versus vehicle-towed array (VTA) instruments and inclusion of detector-aided reconnaissance (DAR)</td><td>Date: 3/2/11

☒ Applicable
☒ Evaluated
☒ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☒ Economic ☒ Social</td><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="2">Resources Conserved:
☒ Hazardous air pollutants ☒ Energy ☒ Waste
☒ Criteria pollutants ☒ Materials ☒ Safety/Community
☒ GHG emissions (CO2e) ☒ Water ☒ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

The December 2010 Draft FFS and current remedy selection activities are an attempt to develop and evaluate alternatives to the current remedy given site conditions. The cost and up-front investment regarding GSR are hard to quantify.</td></tr>
</table>

<table>
<tr><td colspan="3">BMP B-4: Establish decision points to trigger a change from one technology to another or from one remedy alternative to another
Examples:
- Change vapor treatment from thermal oxidation to granular activated carbon (GAC) media based on flow rates and concentrations
- Remove a treatment polishing step if influent to that step already meets discharge criteria
- Move to Monitored Natural Attenuation (MNA) if specific concentration thresholds in groundwater are met</td><td>Date: 3/2/11

☒ Applicable
☐ Evaluated
☐ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting
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<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
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If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

The ROD was based on a “trigger point” approach, which for instance led to implementation of the contingent P&T system. At this point, such triggers moving forward will be difficult to define until issues regarding aquifer classification and background concentrations are fully resolved. The cost and up-front investment regarding GSR are hard to quantify.</td></tr>
</table>

BMP Category B: Characterization and/or Remedy Approach

<table>
<tr><td colspan="3">BMP B-5: Focus sampling efforts to meet objectives of the specific remedial phase (e.g., sampling during O&M should be focused on evaluating remedy performance and not on thorough plume characterization)
Examples:
- Eliminate sampling parameters as appropriate
- Reduce sampling frequency as appropriate
- Reduce sample locations as appropriate
- Enhance monitoring program as appropriate
- MMRP projects: consider Incremental Sampling Methodology (ISM) versus discrete sampling for MC characterization</td><td>Date: 3/2/11

☒ Applicable
☒ Evaluated
☒ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☐ Fully ☐ Partially ☒ Not Yet ☐ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
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<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
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<tr><td colspan="2">Resources Conserved:
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☒ GHG emissions (CO2e) ☒ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

This concept applies, and it is recognized that the actual sampling plan will depend on the remedy that is selected. MNA would require more intense monitoring during the first five years to establish trends. A sampling plan will be fully defined after the remedy is selected, and will be based on that specific remedy.</td></tr>
</table>

BMP Category B: Characterization and/or Remedy Approach

<table>
<tr><td colspan="2">BMP B-6: Consider real-time measurements and dynamic work plans to reduce mobilizations and improve effectiveness of investigation efforts
Examples:
- Field test kits (e.g., test kits for sulfate)
- Field screening instruments (e.g., x-ray fluorescence for lead or photoionization detectors for volatile organics)
- Drive point sensor technologies (e.g., membrane interface probe or “MIP”)
- Visual staining or odor
- Establish excavation extent based on real-time data collected as excavation proceeds and use GPS to accurately delineate excavation areas
- MMRP projects: use GPS and/or the same equipment that was used for detection to confirm anomaly signatures prior to excavating
- MMRP projects: consider incorporating field screening methods (e.g., X-ray fluorescence, EXPRAY and explosives test kits, as appropriate or applicable) into the field program to refine sampling locations and reduce the quantities of samples submitted for off-site laboratory analysis</td><td>Date: 3/2/11

☒ Applicable
☒ Evaluated
☒ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A</td><td colspan="2">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
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<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
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<tr><td>Resources Conserved:
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☒ GHG emissions (CO2e) ☒ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Notes (including discussion of possible value of implementing the BMP):

Arsenic field test kits were used for the investigation during Summer 2010 in lieu of excessive lab analysis. This had the added benefit of providing an instantaneous reading. Geoprobe and rotosonic drilling were primarily used during this investigation.

Iron test kits were also used during the treatability study.</td></tr>
</table>

BMP Category B: Characterization and/or Remedy Approach

BMP B-7: Consider use of existing site structures/infrastructure or mobilization of temporary structures versus new construction Examples: - Buildings (e.g., for treatment building or field office) - Concrete slabs or foundations - Wells - Existing excavations for storm water control	**Date:** 3/2/11 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☒ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Alternative 3 would use the existing treatment building and equipment. Although new injection wells would need to be installed, existing extraction wells would be used and existing monitoring wells would be used to the extent possible. The existing line to the POTW would also remain in place in case all of the water cannot be injected. The LTM plan will incorporate existing MWs to the extent possible.

BMP B-8: Establish project-specific decision points to limit extent of remediation Examples: - Project-specific cleanup levels based on a site-specific risk assessment (coordinated with risk assessment experts) rather than generic cleanup levels, if it results in lower footprints for key parameters and is acceptable to all stakeholders - MMRP projects: dig stopping rules and anomaly prioritization/detection criteria to minimize false positives	**Date:** 3/2/11 ☒ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

The Project Team is attempting to do this by pushing for the reclassification of the aquifer and the definition of background levels. These measures would allow for cleanup to less stringent levels. This is an ongoing process at this point.

BMP Category B: Characterization and/or Remedy Approach

<table>
<tr><td colspan="3">BMP B-9: Consider leaving in place structures whose removal is not necessary (i.e., foundations, underground pillars, etc.)</td><td>Date: 3/2/11
☒ Applicable
☐ Evaluated
☐ Practical</td></tr>
<tr><td>Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
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<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
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<tr><td colspan="2">Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

The aboveground treatment plant would be decommissioned if the MNA alternative is chosen, but this would only involve items like removing pumps and capping pipes. Demolition of the building and removal of underground pipes is not planned. This decommissioning will be evaluated in more detail during design if the remedy selected does not include P&T.</td></tr>
</table>

BMP Category C: Energy/Emissions – Transportation

BMP C-1: Reduce the number of trips for personnel Examples: - Encourage carpooling - Use telemetry systems and webcams to remotely transmit data directly to project offices to avoid trips	**Date:** 3/2/11 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☒ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☐ Waste ☒ Criteria pollutants ☐ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Efforts are made to reduce the number of trips for field work and to couple jobs when possible.

ECC makes up to three site visits per week since the current treatment system requires frequent attention. Less labor effort may be required after the final remedy decision is made.

A telemetry system is in place, consisting of an autodialer for notifications and alarms, but flow rates cannot be managed using the current system.

BMP C-2: Reduce the number of trips and/or volume for transported materials, equipment, or waste Examples: - Transfer full loads by consolidating shipments from vendors and/or shipments to disposal sites (also share shipments with neighbors if feasible) - Purchase more concentrated chemicals to reduce transportation weight and/or volume	**Date:** 3/2/11 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☐ Waste ☒ Criteria pollutants ☐ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Chemicals for this project are currently purchased in bulk.

Trips to disposal sites are made as infrequently as possible in order to optimize cost.

BMP Category C: Energy/Emissions – Transportation

BMP C-3: Reduce trip lengths
Examples:
- Dispose of waste at closest appropriate facility
- Purchase materials, equipment, and services from local vendors
- Use locally produced supplies
- Select most efficient transportation route

Date: 3/2/11
☐ Applicable
☐ Evaluated
☐ Practical

Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☒ Economic ☒ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☒ Hazardous air pollutants ☒ Energy ☐ Waste
☒ Criteria pollutants ☐ Materials ☒ Safety/Community
☒ GHG emissions (CO2e) ☐ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

GSR considerations for this BMP are outweighed by cost optimization due to the performance-based contract.

BMP C-4: Use alternate fuels or other options for transportation when possible
Examples:
- Compressed natural gas
- Biodiesel blends
- Ethanol blends
- Hybrid and/or electric
- Rail lines versus trucks
- Use a fuel efficient passenger car rather than a pickup truck if task allows

Date: 3/2/11
☐ Applicable
☐ Evaluated
☐ Practical

Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☒ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☐ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☐ Hazardous air pollutants ☒ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☒ GHG emissions (CO2e) ☐ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

It is too early in the process for this BMP to be applied, but it should be considered during design and construction.

BMP Category D: Energy/Emissions – Equipment Use

BMP D-1: Consider and implement approaches to minimize engine idle times	**Date:** 3/2/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☐ Waste ☒ Criteria pollutants ☐ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *It is too early in the process for this BMP to be applied, but it should be considered during design and construction.*	

BMP D-2: Ensure peak operating efficiency of equipment to reduce energy use and emissions Examples: - Perform preventative maintenance and operate equipment per manufacturer instructions - Perform retrofits involving low-maintenance multi-stage filters for cleaner engine exhaust - Use synthetic oil to extend operating life (and reduce waste oil) - Purchase newer equipment with reduced emissions	**Date:** 3/2/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☒ Energy ☐ Waste ☒ Criteria pollutants ☐ Materials ☐ Safety/Community ☒ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *It is too early in the process for this BMP to be applied, but it should be considered during design and construction.*	

BMP Category D: Energy/Emissions – Equipment Use

<table>
<tr><td colspan="3">BMP D-3: Use alternate fuel options for equipment when possible
Examples:
- Compressed natural gas
- Biodiesel
- Ethanol blends
- Ultra-low sulfur diesel, wherever available (and as required by engines with PM traps)</td><td>Date: 3/2/11
☐ Applicable
☐ Evaluated
☐ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
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<tr><td colspan="2">Resources Conserved:
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If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

It is too early in the process for this BMP to be applied, but it should be considered during design and construction.</td></tr>
</table>

<table>
<tr><td colspan="3">BMP D-4: Select appropriate equipment and/or power source for the job
Examples:
- Avoid using large excavators for small earthmoving projects
- Use direct push methods when possible to reduce drilling duration
- Compare potential use of electricity versus battery versus generator</td><td>Date: 3/2/11
☒ Applicable
☒ Evaluated
☒ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting
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If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

Direct push was used for sampling during the investigation.

When drilling, an attempt is made to use the smallest rig possible.

Low flow sampling is used.</td></tr>
</table>

BMP Category D: Energy/Emissions – Equipment Use

BMP D-5: Use variable frequency drives on motors (e.g., pumps, blowers), or replace oversized motors with properly sized motors	**Date:** 3/2/11 ☒ Applicable ☒ Evaluated ☒ Practical

Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☒ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☐ Waste ☒ Criteria pollutants ☐ Materials ☐ Safety/Community ☒ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

VFDs are used on the two extraction pumps as well as the two pumps for the microfilter.

BMP D-6: Identify options for generating renewable energy for direct use in the remedy and/or for alternate use at or near the project site Examples: - Solar, wind, landfill gas (microturbines), combined heat and power, geothermal heat exchange - Applications for remote areas such as solar pumps or solar flares (if demand is not continuous, the need for a battery backup may be avoided) - Generate power or heat exchange from water to be discharged	**Date:** 3/2/11 ☒ Applicable ☐ Evaluated ☐ Practical

Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☒ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☐ Waste ☒ Criteria pollutants ☐ Materials ☐ Safety/Community ☒ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

This is applicable to the current remedy, but may not be applicable to the selected future remedy. A heat exchanger could be used in Alternatives 1 and 3 using the extracted water, as discussed in Section 5.5.1 of the RSE. That analysis suggested a capital cost in the order of $15,000, net savings of $4,500 per year due to offset electrical usage (i.e., payback in less than 4 years), and reductions in energy use, GHG emissions, etc. This option could be incorporated into Alternatives 1 and 3 to eliminate the need for the building heater. This BMP would not be applicable to the other remedy alternatives.

BMP Category D: Energy/Emissions – Equipment Use

BMP D-7: Consider purchase of renewable energy certificates to offset emissions from the remedial activities	**Date:** 3/2/11 ☒ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☒ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☒ Energy ☐ Waste ☒ Criteria pollutants ☐ Materials ☐ Safety/Community ☒ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

This is applicable to the current remedy, but may not be applicable to the selected future remedy. The purchase of RECs could offset footprints resulting from electricity used for the project, but this would not be done under the current contract due to increased cost (i.e., not considered practical). This may not be applicable to several of the remedial alternatives (MNA or barrier walls) which do not use electricity.

BMP D-8: Design/modify housing required for above-ground treatment components for energy-efficiency Examples: - Passive lighting - Compact fluorescent lighting (CFL) or light-emitting diode (LD) lighting - Timers and/or motion control sensors for lighting - Shading - Minimize heating and cooling needs (building size, insulation, etc.)	**Date:** 3/2/11 ☒ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☐ Waste ☒ Criteria pollutants ☐ Materials ☐ Safety/Community ☒ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

This is applicable to the current remedy, but may not be applicable to the selected future remedy. This could be considered further if a remedy involving P&T is selected.

BMP Category D: Energy/Emissions – Equipment Use

BMP D-9: For remedies that involve groundwater or air extraction, optimize extraction to reduce flow rates (potentially beneficial with respect to energy use, materials usage, water resources, waste disposal, etc.)	**Date:** 3/2/11 ☒ Applicable ☒ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☐ Waste ☒ Criteria pollutants ☐ Materials ☐ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Groundwater modeling has been used to model flow rates and optimize capture. At this point, there does not appear to be an option to reduce pumping below 50 gpm for the current remedy. If an alternative to P&T is selected, extraction and treatment will be eliminated.*	

BMP D-10: Consider pulsing for extraction of water or air to maximize mass removal per unit of time or energy, by extracting higher concentrations	**Date:** 3/2/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP is not applicable for this project, since the focus of the remedy is containment rather than mass removal.*	

BMP Category D: Energy/Emissions – Equipment Use

BMP D-11: Run electrical equipment during times of lower electric demand if possible (this does not reduce energy use but could lower cost and also can lower stress on the energy grid during periods of peak demand)	**Date:** 3/2/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

This BMP is not applicable for this project, since the system must be kept running continuously.

BMP Category E: Materials & Off-Site Services

<table>
<tr><td colspan="3">BMP E-1: Use materials that are made from recycled materials
Examples:
- Steel
- Asphalt
- Plastics
- Concrete</td><td>Date: 3/2/11
☐ Applicable
☐ Evaluated
☐ Practical</td></tr>
<tr><td>Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☐ Economic ☐ Social</td><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="2">Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☒ Waste
☐ Criteria pollutants ☒ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

It is too early in the process for this BMP to be applied, but it should be considered during design and construction.</td></tr>
</table>

<table>
<tr><td colspan="3">BMP E-2: Optimize the amount of materials used
Examples:
- Experiment with different material amounts/doses
- Consider alternate materials
- Use timers or feedback loops and process controls for dosing
- MMRP projects: minimize quantities of donor explosives for MEC destruction</td><td>Date: 3/2/11
☒ Applicable
☐ Evaluated
☐ Practical</td></tr>
<tr><td>Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☐ Economic ☐ Social</td><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="2">Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☒ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

This is applicable to the current remedy, but may not be applicable to the selected future remedy. The RSE report discusses potential alternatives to the sodium chlorite currently being used. This should be considered in detail of Alternative 1 is selected.</td></tr>
</table>

BMP Category E: Materials & Off-Site Services

BMP E-3: Utilize less refined materials when feasible Examples: - Limestone instead of sodium hydroxide for pH adjustment - Native fill instead of select fill	**Date:** 3/2/11 ☒ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☒ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Potentially applicable, depending on remedy selected. Sodium hypochlorite could be used as an oxidant in place of sodium chlorite, if Alternative 1 is selected.*	

BMP E-4: Identify opportunities for using by-products or "waste" materials from local sources in place of refined chemicals or materials Examples: - Cheese whey, molasses, compost, or off-spec food products for inducing anaerobic conditions - Crushed concrete for use as fill - Concrete from coal combustion byproducts	**Date:** 3/2/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☒ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *It is too early in the process for this BMP to be applied, but it should be considered during design and construction.*	

BMP Category E: Materials & Off-Site Services

BMP E-5: Reduce demand on Publicly Owned Treatment Works (POTWs) Examples: - Discharge treated water to groundwater or to surface water rather than POTW - Minimize amount of water requiring treatment	**Date:** 3/2/11 ☒ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Discharge water is currently being sent to the POTW. This would be discontinued in all the alternatives except Alternative 1. However, it was stated that water from the P&T system is not considered to be stressing the capacity of the POTW.

Treated water could be discharged to surface water, but as there are a large number of other constituents that would require further treatment, this option is not being considered.

BMP Category F: Water Resource Use

BMP F-1: Minimize water consumption
Examples:
- Sensors to turn off water when not needed
- Low flow fittings
- Minimize water needs for irrigation (landscape choices, use of mats and mulch)

Date: 3/2/11
☐ Applicable
☐ Evaluated
☐ Practical

Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☒ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

This BMP is not applicable for this project.

BMP F-2: Preferentially use less refined water resources when feasible
Examples:
- Use extracted groundwater instead of potable water for chemical blending
- Capture and store rain/storm water for future use
- Employ rumble grates with a closed-loop gray-water washing system

Date: 3/2/11
☐ Applicable
☐ Evaluated
☐ Practical

Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

A minor amount of potable water is used for mixing with chemicals. Using less refined water sources could be considered if feasible, but this will only apply if Alternative 1 is selected.

BMP Category F: Water Resource Use

BMP F-3: Use extracted and treated water for beneficial purposes Examples: - Irrigation - Potable water - Industrial process water	**Date:** 3/2/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☒ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP is not applicable for this project.*	

BMP F-4: Promote groundwater recharge Examples: - Recharge extracted and treated water when beneficial uses of the water are not identified and reinjection is practical - Minimize site area covered by impervious surfaces to reduce runoff and maximize infiltration (unless such capping is a specific component of the remedial action)	**Date:** 3/2/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☒ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP is not applicable for this project. Alternative 3 includes recharge, but that would be recharge of impacted water which would not be considered "beneficial use" from a GSR perspective.*	

BMP Category F: Water Resource Use

<table>
<tr><td colspan="3">BMP F-5: Maintain water quality by preventing nutrient loading to surface water or groundwater
Examples:
- Use phosphate-free detergents instead of organic solvents or acids to decontaminate sampling equipment (if not required for some contaminants)</td><td>Date: 3/2/11
☐ Applicable
☐ Evaluated
☐ Practical</td></tr>
<tr><td>Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☐ Economic ☐ Social</td><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="2">Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☒ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

This BMP is not applicable for this project.</td></tr>
</table>

BMP Category G: Waste Generation, Disposal, and Recycling

BMP G-1: Minimize drill cuttings and all other investigation derived waste (including personal protection equipment)

Examples:

- Direct push or sonic drilling to reduce drill cuttings
- Low-flow sampling or passive diffusion bags (if applicable) to reduce purge water
- When possible place drill cuttings on-site rather than off-site disposal

Date: 3/2/11

☒ Applicable

☒ Evaluated

☒ Practical

Implemented?
("N/A" if "Practical" not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☒ Economic ☒ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☒ Hazardous air pollutants ☒ Energy ☒ Waste
☒ Criteria pollutants ☒ Materials ☒ Safety/Community
☒ GHG emissions (CO2e) ☒ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Geoprobe and rotosonic drilling have been used, which minimizes drill cuttings. Drill cuttings are not considered hazardous and do not require off-site disposal; they are typically spread on the surface. Purge water is discharged to the ground.

A modified solids handling approach was discussed in Section 5.2.3 of the RSE, and could be considered further if Alternative 1 is selected. It would require a capital cost on the order of $100,000 and have a payback period of approximately 5 years. However, it would not apply if Alternative 1 is not selected.

BMP G-2: Segregate excavated soil in pre-planned staging areas so that "clean" material can be deposited on-site and/or reused rather than transported for off-site disposal

Date: 3/2/11

☐ Applicable

☐ Evaluated

☐ Practical

Implemented? ("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

This BMP is not applicable for this project.

BMP Category G: Waste Generation, Disposal, and Recycling

<table>
<tr><td colspan="3">BMP G-3: Consider on-site treatment and re-use of soil instead of off-site disposal
Examples:
- Land farming
- Above ground soil vapor extraction (SVE)</td><td>Date: 3/2/11
☐ Applicable
☐ Evaluated
☐ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social</td><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="2">Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

This BMP is not applicable for the current remedy. It may apply to the PRB alternative, in which case soil would be placed on top of the landfill/below the cap. Off-site disposal is not being considered.</td></tr>
</table>

<table>
<tr><td colspan="3">BMP G-4: Minimize need to transport and dispose hazardous waste
Examples:
- Consider delisting listed hazardous waste if waste is not characteristically hazardous waste
- Segregate hazardous waste and non-hazardous waste</td><td>Date: 3/2/11
☐ Applicable
☐ Evaluated
☐ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
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<tr><td colspan="2">Resources Conserved:
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☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

This BMP is not applicable for this project, as there is no hazardous waste.</td></tr>
</table>

BMP Category G: Waste Generation, Disposal, and Recycling

BMP G-5: When possible avoid/minimize use of hazardous/toxic materials that may require special handling or disposal

Examples:

- Cleaning solutions
- Pesticides
- Disposable batteries (use rechargeable batteries)
- MMRP projects: minimize Chemical Agent Contaminated Media (CACM) at RCWM sites.

Date: 3/2/11

☐ Applicable

☐ Evaluated

☐ Practical

Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☒ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☒ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

This BMP is not applicable for this project.

BMP G-6: Recycle or reuse materials rather than disposing of them

Examples:

- Cardboard
- Plastics
- Concrete
- Asphalt
- Steel and other metals
- Recovered oil/product
- Mulch/compost
- MMRP projects - recycle recovered Material Documented as Safe (MDAS) after inspection and certification that the remnants are free of explosive hazards

Date: 3/2/11

☒ Applicable

☒ Evaluated

☒ Practical

Implemented?
("N/A" if "Practical" not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☐ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☒ Waste
☐ Criteria pollutants ☒ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Containers for gas are sent back to the supplier and re-used.

BMP Category H: Land Use, Ecosystems, and Cultural Resources

BMP H-1: Minimize erosion and soil transport to surface water bodies Examples: - Quickly restore any vegetated areas disrupted by equipment or vehicles - Institute appropriate erosion controls during excavation such as silt fencing	**Date:** 3/2/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☒ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *It is too early in the process for this BMP to be applied, but it should be considered during design and construction.*	

BMP H-2: Minimize disturbances to land Examples: - Establish well-defined traffic patterns for onsite activities to minimize disturbed areas - Consider non-intrusive investigation techniques (e.g., geophysical methods) to identify items like USTs and buried drums	**Date:** 3/2/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☒ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *It is too early in the process for this BMP to be applied, but it should be considered during design and construction.* *The Project Team has tried to limit the amount of intrusive work. No major disturbances are anticipated.*	

BMP Category H: Land Use, Ecosystems, and Cultural Resources

<table>
<tr><td colspan="2">BMP H-3: Preserve/restore ecosystems to the extent possible
Examples:
- Limit the removal of trees and vegetation
- Attempt to transplant disturbed shrubs and small trees to other locations
- Use native species for re-vegetation
- Retrieve dead trees during excavation and later reposition them as habitat snags
- Select and place suitably sized and typed stones into water beds and banks
- Undercut surface water banks in ways that mirror natural conditions
- Cut back rather than remove trees, bushes, vegetation</td><td>Date: 3/2/11

☐ Applicable
☐ Evaluated
☐ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A</td><td colspan="2">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
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<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☐ Economic ☐ Social</td><td colspan="2">Level of Up-Front Investment Included in 5 Year Cost Impact:
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<tr><td>Resources Conserved:
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☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☒ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Notes (including discussion of possible value of implementing the BMP):

The only disturbance would occur in the vicinity of the containment wall. This would consist of open, grassy areas (no trees or other vegetation) which would be restored afterward.

This BMP is considered not applicable because the project team indicated that they did not believe that any of the construction would impact ecosystems in a significant way.</td></tr>
</table>

<table>
<tr><td colspan="2">BMP H-4: Minimize drawdown of the water table in sensitive areas such as wetlands or areas subject to subsidence</td><td>Date: 3/2/11
☒ Applicable
☒ Evaluated
☒ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A</td><td colspan="2">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
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<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
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<tr><td>Resources Conserved:
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☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☒ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Notes (including discussion of possible value of implementing the BMP):

The current pumping is not affecting any nearby wetlands. Pumping upgradient of Plow Shop Pond was screened out in order to prevent impacts to wetlands.</td></tr>
</table>

BMP Category H: Land Use, Ecosystems, and Cultural Resources

BMP H-5: Construct wells and other remedial process infrastructure (piping, buildings, etc.) to minimize restrictions to anticipated future use of the site	**Date:** 3/2/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☒ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Future land use is not explicitly discussed in the December 2010 Draft FFS.*	

BMP H-6: Preserve/restore cultural resources to the extent possible Examples: - Protected lands such as wildlife refuges, national parks, and wilderness areas - Culturally sensitive sites such as cemeteries, native burials, and archaeological finds - Buildings or land parcels with historical significance	**Date:** 3/2/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☒ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *There are no identified cultural resources in the area that would potentially be impacted by remediation activities for the identified alternatives.*	

BMP Category H: Land Use, Ecosystems, and Cultural Resources

<table>
<tr><td colspan="3">BMP H-7: Document sensitive ecological and cultural resources prior to initiating actions that might diminish or destroy those resources
Examples:
- Photodocument conditions prior to clearing brush
- MMRP projects: photodocument conditions prior to BIP</td><td>Date: 3/2/11
☐ Applicable
☐ Evaluated
☐ Practical</td></tr>
<tr><td>Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
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<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
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☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

There are no identified ecological or cultural resources in the area that would potentially be impacted by remediation activities.</td></tr>
</table>

BMP Category I: Safety and Community

<table>
<tr><td colspan="3">BMP I-1: Minimize and mitigate noise, light and odor disturbance during all phases of the remedial process, to the extent practicable</td><td>Date: 3/2/11
☐ Applicable
☐ Evaluated
☐ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
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☐ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

There are no issues to date. This BMP should be considered during design and construction of any of the possible remedy alternatives.</td></tr>
</table>

<table>
<tr><td colspan="3">BMP I-2: Minimize dust during construction activities by spraying water or techniques such as laying biodegradable mats, tarps, or materials (already in EM385-1-1)</td><td>Date: 3/2/11
☐ Applicable
☐ Evaluated
☐ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
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<tr><td colspan="2">Resources Conserved:
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☐ Criteria pollutants ☐ Materials ☒ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☒ BMP otherwise required?
If checked, required by:
EM385-1-1</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

It is too early in the process for this BMP to be applied, but it should be considered during design and construction.</td></tr>
</table>

BMP Category I: Safety and Community

BMP I-3: Select transportation routes for trucks and heavy equipment that minimize impacts to residential areas to maximize safety and minimize noise and other aesthetic impacts	**Date:** 3/2/11 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☒ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

A few residences exist along Scully Road, which provides access to the site. An alternate route to the south of the landfill goes by industrial areas only.

BMP I-4: Minimize drawdown of the water table in areas that could impact production rates at supply wells and/or irrigation wells	**Date:** 3/2/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☒ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

This BMP is not applicable for this project.

BMP Category I: Safety and Community

BMP I-5: Minimize amount of time that heavy machinery is needed to enhance safety	**Date:** 3/2/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < \$10,000 ☐ \$10,001 - \$50,000 ☐ \$50,001 - \$100,000 ☐ \$100,001 - \$500,000 ☐ > \$500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☒ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

It is too early in the process for this BMP to be applied, but it should be considered during design and construction.

BMP I-6: Minimize handling of dangerous chemicals by selecting alternate chemicals and/or engineering to minimize contact with chemicals (for MMRP projects, there is enhanced risk related to explosion potential and exposure to chemical agents (CA) and agent breakdown products (ABP) associated with RCWM responses)	**Date:** 3/2/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < \$10,000 ☐ \$10,001 - \$50,000 ☐ \$50,001 - \$100,000 ☐ \$100,001 - \$500,000 ☐ > \$500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☒ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

This BMP is not applicable for this project.

BMP Category I: Safety and Community

BMP I-7: Contribute to local economy when possible Examples: - Consider leasing local office space - Purchase or lease equipment from local vendors - Hire workers from local community	**Date:** 3/2/11 ☒ Applicable ☒ Evaluated ☒ Practical

Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☒ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

A local contractor is being used for O&M. Local contractors are also being used for plowing, mowing, and possibly for electrical work.

BMP Category J: Other Site-Specific BMPs

<table>
<tr><td colspan="2">BMP J-1:</td><td>Date:
☐ Applicable
☐ Evaluated
☐ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☐ Fully ☐ Partially ☐ Not Yet ☐ N/A</td><td colspan="2">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
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<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social</td><td colspan="2">Level of Up-Front Investment Included in 5 Year Cost Impact:
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<tr><td>Resources Conserved:
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☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Notes (including discussion of possible value of implementing the BMP):</td></tr>
</table>

<table>
<tr><td colspan="2">BMP J-2:</td><td>Date:
☐ Applicable
☐ Evaluated
☐ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☐ Fully ☐ Partially ☐ Not Yet ☐ N/A</td><td colspan="2">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social</td><td colspan="2">Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td>Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Notes (including discussion of possible value of implementing the BMP):</td></tr>
</table>

APPENDIX B

Assumptions for SiteWise Input and Other Calculations
Shepley's Hill Landfill Pilot GSR Evaluation
Alternative 1 – No Action (Current System)

Appendix B
Assumptions for SiteWise Input and Other Calculations
Shepley's Hill Landfill Pilot GSR Evaluation
Alternative 1 – No Action

Alternative 1 – No Action (Baseline P&T Remedy) – SiteWise "Alternative 1" Directory

- 2 extraction wells pumping 50 gpm total
- One treatment plant with solids disposal and pumped discharge
- Process monitoring of plant influent and effluent and semi-annual groundwater monitoring
- System replacement every 30 years
- 100 years of operation

The notes pertaining to SiteWise input are organized by the following sections of SiteWise input:

- System O&M – Uses "Remedial Action Operations" tab of SiteWise input for SiteWise "Alternative 1"

- LTM – Uses "Longterm Monitoring" tab of SiteWise input for "SiteWise "Alternative 1"

For each section of SiteWise, all the sections are listed, with pertinent information added only for those sections of the input sheet where data were added.

Other calculations done outside of SiteWise are then presented. These include the following:

- % of total energy from renewable resources
- Hazardous Air Pollutants
- Refined Material Use
- Unrefined Material Use
- Tons of non-hazardous waste
- Tons of hazardous waste
- Risks to on-site works and from transportation
- Heavy truck trips through residential areas

Additional tables are attached which show how SiteWise outputs were split into "direct" and "indirect" energy use and greenhouse gas emissions. For definitions of direct and indirect energy use and emissions, please refer to section 2.2.2 of the evaluation report.

A cost sheet is also attached. Some of the information on the cost sheet comes from Appendix C of the December 2010 Draft FFS (also attached). Information regarding the cost calculations is as follows:

Alternative 1 - Description

- The capital cost for Alternative 1 is $0, since it does not involve any changes to the current system.

- The annual cost of $600,000 for the first ten years and $575,000 for the subsequent ninety years is taken from Table C-1 of the December 2010 Draft FFS. Table C-1 also includes three ATP replacements during a 100 year period priced at $1,500,000 each.

- Capital costs are assumed to occur in year 0, and annual costs are assumed to occur in years 1 to 100.

- To determine net present value (NPV), a 2.7 percent discount rate is applied to future costs, which is consistent with the discount rate applied in the December 2010 Draft FFS.

- NPV is calculated by discounting future costs to present-day dollars using the following equation:

$$PV = \frac{FV}{(1+i)^n} = C \times FV$$

PV is the present value
FV is the value in year "n" (i.e., future value)
i is the discount rate
C is the discount factor, which equals $1/(1+i)^n$

The power to operate pumps and blowers is proportional to the cube of the pump or blower speed. Based on this relationship, the following equation is used to estimate the electricity used by a motor with a VFD.

$$HP_{eff} = \frac{HP \times L_V{}^3}{\eta_v}$$

HP_{eff} = effective horsepower for pump operated with VFD to enter into SiteWise (includes efficiency of VFD)
HP = rated horsepower of motor
L_V = % of VFD full load (or speed in Hertz divided by 60 Hertz)
η_v = efficiency of VFD (80% for VFD speed settings of approximately 50% to 75% of full speed)

For VFDs in SiteWise, enter 100% for pump load because the pump load is integral to the L_v parameter and use the default or otherwise appropriate motor efficiency.

None of the alternatives address landfill emission, and it is assumed that landfill gas is addressed as part of landfill post-closure and not included in this analysis. Some amount of methane would be released from extracted groundwater. It is assumed that this methane would volatize from groundwater anyway. Therefore, methane emissions from extracted groundwater are not considered.

Alternative 1 – System O&M

<u>Scope of Work</u>

- Extraction pumps
  - 2 extraction wells, each with 5 HP electric submersible pump with a VFD; VFD frequency for typical pump operation = 33 Hz (at time of RSE), which is approximately half of the pump's rated speed
  - Both wells are 6 inches in diameter, 88 ft and 98 ft deep, with 25-ft screen intervals
  - Maximum system flow rate = 50 gpm combined for two wells, average flow rate over the course of the month = ~42 gpm due to downtime associated with system backwashes (at time of RSE). RSE estimated future operating rate of **45 gpm**
  - Assume pumps operate for 100 yrs = 876,000 hrs.
- Treatment system
  - Uses ~150 gallons per day of potable water for polymer dilution
  - Chlorine dioxide addition
    - Generated on-site by mixing chlorine gas with 25% sodium chlorite solution, uses ~2400 gallons per day of potable water
    - Chemicals fed into process water with a 0.75 HP feed pump (assumed to operate continuously)
    - At 45 gpm, 7,000 gallons (or 70,000 lbs) of sodium chlorite per year
    - At 45 gpm, 9,000 lbs of chlorine gas per year
    - Chlorine gas locally available
    - Sodium chlorite likely manufactured in either IL, KS, or NC
  - Coagulation using in-line rapid mixing
    - Mixing in 3-inch PVC line requires 0.5 HP motor (assumed to operate continuously)
  - Contact tank
    - 2 tanks, each with 0.5 HP mixers (assumed to operate continuously)
  - Microfiltration unit rated for 50 gpm
    - Backwashes every 14 minutes for 1.5 minutes
    - Each backwash event generates ~67 gallons of solids laden water discharged to lamella-plate clarifier for solids thickening
    - 3 HP feed pump with VFD set at 61% during forward flow
    - 3 HP backwash pump with VFD set at 59% for first 60 seconds and 71% for following 30 seconds
    - Clean-in-place for 12 hours each, less than once per month, uses ~600 gallons of potable water
- Solids handling
  - 0.75 HP progressive cavity pump sends water to filter bottom container
  - ~1,600 lbs of solids generated from treating 1.25 million gallons of water
  - Solids collected with vactor truck and hauled to Turnkey Landfill in Rochester, NH (86 miles one way)
  - ~ 21 disposal events per year
  - 8-10 tons of material (or < 8-10 cy volume) disposed of each time→solids fraction of 8% to 9% by weight
  - Each year, ~189 tons of solids disposed of in a landfill as non-hazardous waste
- Discharge to Devens POTW
  - 2 pumps, 5 HP each, operating in alternating mode

    - Pump water through 3-inch discharge line that runs the length of the landfill from north to south to the Devens sewer
    - At 45 gpm, 64,800 gallons sent to POTW per day
- Annual electricity usage (from utility bills) = ~145,200 kWh, which the RSE report estimated as a baseline of ~9,100 kWh per month for motor operation for pumps and mixers and an additional 6,000 kWh per month from December through May for electric heating.
- ~20 hrs of labor billed to site each week
- System replacement every 30 years
    - The specific materials, equipment, and labor hours required are unknown. Therefore, detailed footprinting using SiteWise was not done for this component of this remedial alternative.
    - Based on *U.S. Carbon Dioxide Emissions and Intensities Over Time: A Detailed Accounting of Industries, Government and Households* (April 2010), approximately 1 lb (0.00045 metric tons) of CO2 is emitted per dollar of United States GDP. In the absence of other information, it is assumed that the specified activity also has an emission profile of approximately 1 lb of CO2 emitted per dollar of cost. This emission is likely based on a mix of fuel uses and activities.
    - The non-discounted cost for the three treatment plant replacements over the course of 100 years of remedy operation is estimated at $1,500,000 each, for a total cost of $4,500,000. This would lead to the emission of approximately 4,500,000 lbs of CO2, or 2041 metric tons of CO2.

Alternative 1 – System O&M

<u>SiteWise Input – Input into "Remedial Action Operation" tab of SiteWise "Alternative 1"</u>

- Material Production
    - Well Materials
    - Treatment Chemicals & Materials
        - Treatment 1 – Sodium hypochlorite used as a surrogate chemical to represent sodium chlorite (70,000 lbs per year for 100 years). Information for sodium chlorite is not provided in SiteWise.
        - Treatment 2 – Sodium hypochlorite used as a surrogate chemical to represent chlorine gas (9,000 lbs per year for 100 years). Information for chlorine gas is not provided in SiteWise.
    - GAC
    - Construction Materials
    - Well Decommissioning

- Transportation
    - Personnel Transportation – Road
        - Trip 1 – 3 round-trips per week for operator
    - Personnel Transportation – Air
    - Personnel Transportation – Rail
    - Equipment Transportation – Road
        - Trip 1 – locally available chlorine gas from 25 miles away (local). One trip per month for 100 years for a total of 60,000 miles (2*25*12*100=60,000 miles). Average weight per delivery is 750 pounds = 0.375 tons. Average weight per round trip is 0.1875 tons per round trip (0.375/2= 0.1875)
        - Trip 2 – sodium chlorite from a distance of 1000 miles away (not local). Assume 4 deliveries per year for 100 years for a total of (2*1000*4*100=800,000 miles). Average weight per delivery is 17,500 pounds = 8.75 tons. Average weight per round trip is 4.375 tons per round trip (8.75/2=4.375).
    - Equipment Transportation – Air
    - Equipment Transportation – Rail
    - Equipment Transportation – Water

- Equipment Use
    - Earthwork
    - Drilling
    - Pump operation (use method 3), electricity zone NEWE
        - Pump 1 – 2 extraction well pumps
            - HP = $(5*0.5^3)/0.8 = 0.78$ (see VFD formula in introduction)
            - Use 70% efficiency for 5HP submersible pump motor
        - Pump 2 – two 0.75 HP pumps – 1 feed pump for chlorine dioxide addition and 1 progressive capacity pump for water to filter bottom container
            - Use 60% efficiency for fractional-sized above-ground pump motor
        - Pump 3 – microfiltration feed pump (operating for 14 minutes of 15.5 minute cycle
            - HP = $(3*0.61^3)/0.8 = 0.85$
            - Use 70% efficiency for small above-ground pump motor

- Pump 4 – microfiltration backwash pump (operating for 1 minute of 15.5 minute cycle with VFD set at 59%)
  - HP = $(3*.59^3)/0.8 = 0.77$
  - Use 70% efficiency for small above-ground pump motor
- Pump 5 – microfiltration backwash pump (operating for 30 seconds of 15.5 minute cycle with VFD set at 71%)
  - HP = $(3*.71^3)/0.8 = 1.34$
  - Use 70% efficiency for small above-ground pump motor
- Pump 6 – 2 alternating 5 HP pumps for discharge to POTW (i.e., enter one into SiteWise and assume default pump load and motor efficiency)
  - Use 70% efficiency for small above-ground pump motor
- Region – Select "NEWE" for eGRID subregion that includes Massachusetts

- Diesel and Gasoline Pumps
- Blower, Compressor, Mixer, and Other Equipment (electricity zone NEWE)
  - Equipment 1 (method 1, mixer) – 0.5 HP mixer for in-line rapid mixing (continuous operation). Assume 50% efficiency for small fractional-sized HP motor.
  - Equipment 2 (method 1, mixer) – two 0.5 HP contact tank mixers (continuous operation). Assume 50% efficiency for small fractional-sized HP motor.
  - Equipment 3 (method 2, other) – Electric resistive heater for treatment plant freeze protection. 6,000 kWh per month for six months per year for 100 years.
  - Region – Select "NEWE" for eGRID subregion that includes Massachusetts
- Generators
- Agricultural Equipment
- Capping Equipment
- Mixing Equipment

- Residual Handling
  - Residue Disposal/Recycling
    - Other Residuals – 21 trips per year for 100 years to dispose of solids generated from treatment (172 miles round-trip to Turnkey Landfill). Weight of 9 tons per delivery to landfill. In SiteWise, average delivery trip and empty return trip is 9 tons/2 = 4.5 tons per round trip. Use heavy duty truck, diesel.
  - Landfill Operations
  - Thermal/Catalytic Oxidizers
  - Water Consumption
    - Treatment System 1 – 64,800 gallons per day (45 gpm) sent to POTW*365 days*100 years
    - Treatment System 2 – represents potable water used for polymer dilution (150 gpd), generation of chlorine dioxide (2,400 gpd), and average of 10 gpd (600 gallons every 60 days) for bi-monthly clean-in-places
  - Landfill Methane Emissions

- Other Known On-Site Activities
  - CO2 Emissions - The non-discounted cost for the three treatment plant replacements over the course of 100 years of remedy operation is estimated at $1,500,000 each, for a

total cost of \$4,500,000. This would lead to the emission of approximately 4,500,000 lbs of CO_2, or 2041 metric tons of CO_2. (4,500,000/2204.6=2041)

Alternative 1 – LTM

Scope of Work

- Groundwater monitoring
  - Water levels at 67 monitoring wells 2 times per year
  - Water quality sampling at 38 wells in the fall and 16 wells in the spring
  - Low-flow sampling
  - Analytical parameters: field parameters, selected inorganic parameters, metals
  - Reduction in cost after 10 years from $100,000 to $75,000 listed in Table C-1 of the December 2010 Draft FFS. Since no reason for the decrease in cost is listed, it is assumed to be due to analyzing for fewer parameters and not a reduction in the number of wells sampled.
- Process monitoring
  - Effluent sampled 4 times per year for metals and other parameters
  - Effluent sampled 1 time per year for VOCs, SVOCs, and pesticides
  - Influent sampled 1 time per year for VOCs

Alternative 1 – LTM

SiteWise Input – Input into "Longterm Monitoring" tab in SiteWise "Alternative 1"

- Material Production
  - Well Materials
  - Treatment Chemicals & Materials
  - GAC
  - Construction Materials
  - Well Decommissioning

- Transportation
  - Personnel Transportation – Road
    - Trip 1 – water levels (assume 3 people, 1 day, 2 times per year)
    - Trip 2 – sampling (assume 2 people, 6 days in fall and 2 people, 3 days in spring)
    - Note – influent and effluent sampling assumed to be conducted by plant operator and requires no extra trip
  - Personnel Transportation – Air
  - Personnel Transportation – Rail
  - Equipment Transportation – Road
  - Equipment Transportation – Air
  - Equipment Transportation – Rail
  - Equipment Transportation – Water

- Equipment Use
  - Earthwork
  - Drilling
  - Pump operation
  - Diesel and Gasoline Pumps
  - Blower, Compressor, Mixer, and Other Equipment
  - Generators
    - Generator 1 – Sampling pumps
      - Choose smallest generator available in SiteWise
      - Two generators, 9 (6+3) days per year, for 100 years
  - Agricultural Equipment
  - Capping Equipment
  - Mixing Equipment

- Residual Handling
  - Residue Disposal/Recycling
  - Landfill Operations
  - Thermal/Catalytic Oxidizers
  - Water Consumption – Purge water from sampling is negligible
  - Landfill Methane Emissions

- Other Known On-Site Activities

Other Supporting Calculations
Shepley's Hill Landfill Pilot GSR Evaluation
Alternative 1 – No Action (Baseline P&T Option)

% of Total Energy Usage from Renewable Resources

- From SiteWise "Summary.xlsx" sheet, total energy usage is 240,000 MMBtu
- From SiteWise "Summary" tab of "Remedial Action Operations.xlsx" sheet, energy from "Equipment Use & Misc" is 130,000 MMBtu. For this alternative, all equipment use in this cell is electricity use (includes pumps, mixers, and heater). Note that this is not necessarily the case for other alternatives or projects.
- 130,000/240,000 = 54% of energy use is electricity
- From www.epa.gov/egrid, generation mix for NEWE subregion is 11.3% renewable resources, mostly hydro (including large hydro) and biomass
- 54%*11.3% = 6.1% of total energy use is from renewable resources

Hazardous Air Pollutants

None for this alternative.

Refined Materials Use

Assumptions:

- 70,000 pounds per year of sodium chlorite
- 9,000 pounds per year of chlorine gas
- 100% virgin material, 0% recycled material

Unrefined Materials Use

None for this alternative.

Tons of Non-Hazardous Waste

- Solids from filter bottom - 9 tons of waste 21 times per year for 100 years = 18,900 tons

Risks to On-Site Workers and from Transportation

- Refer to "Total" tab of the "Summary.xlsx" spreadsheet.
- For transportation related risks, sum injuries and fatalities for all transportation activities
- Add total risk form transportation and non-transportation, and then subtract the transportation sums previously calculated, to get non-transportation.
- For this alternative, it is all transportation based.

Alternative 1 – Other Calculations

Heavy Truck Trips through Residential Areas

- Project team indicated that trucks could enter through a non-residential route.

Table C-1
Alternative 1 - No Action

Item	Quantity	Units	Unit Cost	Cost per Event/Year	Non-Discounted Cost	Discounted Cost
Study/Design/Capital Costs						
NONE						
Total Capital Costs					**$0**	**$0**

O & M Costs	Quantity	Units	Unit Cost	Cost per Event/Year	Non-Discounted Cost	Discounted Cost
Cap/Groundwater/LUC Monitoring						
Annual Monitoring (years 1-10)	10	years	$100,000 / yr	$100,000	$1,000,000	$866,230
Annual Monitoring (years 11-100)	90	years	$75,000 / yr	$75,000	$6,750,000	$1,934,617
Arsenic Treatment Plant						
Annual O+M	100	years	$500,000 / yr	$500,000	$50,000,000	$17,228,601
ATP Replacement Year 30	1	ea	$1,500,000 / ea	$1,500,000	$1,500,000	$674,494
APT Replacement Year 60	1	ea	$1,500,000 / ea	$1,500,000	$1,500,000	$303,295
ATP Replacement Year 90	1	ea	$1,500,000 / ea	$1,500,000	$1,500,000	$136,380
Total O&M and Monitoring Costs					**$62,250,000**	**$21,143,617**
TOTAL					**$62,250,000**	**$21,143,617**

Discount Rate for Present Value Calculations **2.7%**

Note:

Discount Rate is 30-Year Real Interest Rate from OMB Circular No. A-94 – Appendix C.

Project: GSR Pilot for Shepley's Hill Landfill
Option or Alternative: Alternative 1: No Action
Current Date: 3/4/2011

year	up-front cost	annual cost	present value of cost each year	cumulative cash flow	
		(no discounting)	2.7%	no discounting	2.7%
0	$0	$0	$0	$0	$0
1	$0	$600,000	$584,226	$600,000	$584,226
2	$0	$600,000	$568,867	$1,200,000	$1,153,092
3	$0	$600,000	$553,911	$1,800,000	$1,707,003
4	$0	$600,000	$539,349	$2,400,000	$2,246,352
5	$0	$600,000	$525,169	$3,000,000	$2,771,521
6	$0	$600,000	$511,362	$3,600,000	$3,282,883
7	$0	$600,000	$497,918	$4,200,000	$3,780,801
8	$0	$600,000	$484,828	$4,800,000	$4,265,629
9	$0	$600,000	$472,082	$5,400,000	$4,737,711
10	$0	$600,000	$459,671	$6,000,000	$5,197,382
11	$0	$575,000	$428,936	$6,575,000	$5,626,318
12	$0	$575,000	$417,660	$7,150,000	$6,043,978
13	$0	$575,000	$406,679	$7,725,000	$6,450,657
14	$0	$575,000	$395,988	$8,300,000	$6,846,645
15	$0	$575,000	$385,577	$8,875,000	$7,232,222
16	$0	$575,000	$375,440	$9,450,000	$7,607,662
17	$0	$575,000	$365,570	$10,025,000	$7,973,232
18	$0	$575,000	$355,959	$10,600,000	$8,329,191
19	$0	$575,000	$346,601	$11,175,000	$8,675,791
20	$0	$575,000	$337,488	$11,750,000	$9,013,280
21	$0	$575,000	$328,616	$12,325,000	$9,341,896
22	$0	$575,000	$319,977	$12,900,000	$9,661,872
23	$0	$575,000	$311,564	$13,475,000	$9,973,437
24	$0	$575,000	$303,373	$14,050,000	$10,276,810
25	$0	$575,000	$295,397	$14,625,000	$10,572,207
26	$0	$575,000	$287,631	$15,200,000	$10,859,839
27	$0	$575,000	$280,070	$15,775,000	$11,139,908
28	$0	$575,000	$272,706	$16,350,000	$11,412,615
29	$0	$575,000	$265,537	$16,925,000	$11,678,152
30	$0	$2,075,000	$933,050	$19,000,000	$12,611,201
31	$0	$575,000	$251,758	$19,575,000	$12,862,960
32	$0	$575,000	$245,140	$20,150,000	$13,108,100
33	$0	$575,000	$238,695	$20,725,000	$13,346,794
34	$0	$575,000	$232,420	$21,300,000	$13,579,214
35	$0	$575,000	$226,309	$21,875,000	$13,805,523
36	$0	$575,000	$220,360	$22,450,000	$14,025,883
37	$0	$575,000	$214,566	$23,025,000	$14,240,449
38	$0	$575,000	$208,925	$23,600,000	$14,449,374
39	$0	$575,000	$203,433	$24,175,000	$14,652,807
40	$0	$575,000	$198,084	$24,750,000	$14,850,891

Project: GSR Pilot for Shepley's Hill Landfill
Option or Alternative: Alternative 1: No Action
Current Date: 3/4/2011

year	up-front cost	annual cost	present value of cost each year	cumulative cash flow	
		(no discounting)	2.7%	no discounting	2.7%
41	$0	$575,000	$192,877	$25,325,000	$15,043,768
42	$0	$575,000	$187,806	$25,900,000	$15,231,574
43	$0	$575,000	$182,868	$26,475,000	$15,414,442
44	$0	$575,000	$178,061	$27,050,000	$15,592,503
45	$0	$575,000	$173,380	$27,625,000	$15,765,883
46	$0	$575,000	$168,821	$28,200,000	$15,934,704
47	$0	$575,000	$164,383	$28,775,000	$16,099,087
48	$0	$575,000	$160,061	$29,350,000	$16,259,148
49	$0	$575,000	$155,853	$29,925,000	$16,415,002
50	$0	$575,000	$151,756	$30,500,000	$16,566,758
51	$0	$575,000	$147,766	$31,075,000	$16,714,524
52	$0	$575,000	$143,881	$31,650,000	$16,858,405
53	$0	$575,000	$140,099	$32,225,000	$16,998,504
54	$0	$575,000	$136,416	$32,800,000	$17,134,920
55	$0	$575,000	$132,829	$33,375,000	$17,267,749
56	$0	$575,000	$129,337	$33,950,000	$17,397,086
57	$0	$575,000	$125,937	$34,525,000	$17,523,023
58	$0	$575,000	$122,626	$35,100,000	$17,645,649
59	$0	$575,000	$119,402	$35,675,000	$17,765,051
60	$0	$2,075,000	$419,557	$37,750,000	$18,184,608
61	$0	$575,000	$113,206	$38,325,000	$18,297,814
62	$0	$575,000	$110,230	$38,900,000	$18,408,045
63	$0	$575,000	$107,332	$39,475,000	$18,515,377
64	$0	$575,000	$104,510	$40,050,000	$18,619,887
65	$0	$575,000	$101,763	$40,625,000	$18,721,650
66	$0	$575,000	$99,087	$41,200,000	$18,820,737
67	$0	$575,000	$96,482	$41,775,000	$18,917,220
68	$0	$575,000	$93,946	$42,350,000	$19,011,166
69	$0	$575,000	$91,476	$42,925,000	$19,102,642
70	$0	$575,000	$89,071	$43,500,000	$19,191,713
71	$0	$575,000	$86,729	$44,075,000	$19,278,442
72	$0	$575,000	$84,449	$44,650,000	$19,362,891
73	$0	$575,000	$82,229	$45,225,000	$19,445,121
74	$0	$575,000	$80,067	$45,800,000	$19,525,188
75	$0	$575,000	$77,962	$46,375,000	$19,603,150
76	$0	$575,000	$75,913	$46,950,000	$19,679,063
77	$0	$575,000	$73,917	$47,525,000	$19,752,980
78	$0	$575,000	$71,974	$48,100,000	$19,824,953
79	$0	$575,000	$70,081	$48,675,000	$19,895,035
80	$0	$575,000	$68,239	$49,250,000	$19,963,274
81	$0	$575,000	$66,445	$49,825,000	$20,029,719

Project: GSR Pilot for Shepley's Hill Landfill
Option or Alternative: Alternative 1: No Action
Current Date: 3/4/2011

year	up-front cost	annual cost	present value of cost each year	cumulative cash flow	
		(no discounting)	2.7%	no discounting	2.7%
82	$0	$575,000	$64,698	$50,400,000	$20,094,417
83	$0	$575,000	$62,997	$50,975,000	$20,157,414
84	$0	$575,000	$61,341	$51,550,000	$20,218,755
85	$0	$575,000	$59,728	$52,125,000	$20,278,483
86	$0	$575,000	$58,158	$52,700,000	$20,336,641
87	$0	$575,000	$56,629	$53,275,000	$20,393,270
88	$0	$575,000	$55,140	$53,850,000	$20,448,410
89	$0	$575,000	$53,691	$54,425,000	$20,502,101
90	$0	$2,075,000	$188,659	$56,500,000	$20,690,760
91	$0	$575,000	$50,905	$57,075,000	$20,741,665
92	$0	$575,000	$49,566	$57,650,000	$20,791,231
93	$0	$575,000	$48,263	$58,225,000	$20,839,495
94	$0	$575,000	$46,994	$58,800,000	$20,886,489
95	$0	$575,000	$45,759	$59,375,000	$20,932,248
96	$0	$575,000	$44,556	$59,950,000	$20,976,804
97	$0	$575,000	$43,385	$60,525,000	$21,020,188
98	$0	$575,000	$42,244	$61,100,000	$21,062,432
99	$0	$575,000	$41,133	$61,675,000	$21,103,566
100	$0	$575,000	$40,052	$62,250,000	$21,143,617

Net Present Value (NPV)-> $21,143,617

*positive dollar value is a "cost", negative dollar value is a "savings"

GSR Team Calculations to Split Energy Results from SiteWise into "Direct" and "Indirect"
Alternative 1 - No Action (Current System)

phase	Reported by SiteWise: activity	Reported by SiteWise: energy used (MMBTU)	Assigned by GSR Team from SiteWise Output: Scope 1 (direct) energy used (MMBTU)	Assigned by GSR Team from SiteWise Output: Scope 2 (indirect) energy used (MMBTU)	Assigned by GSR Team from SiteWise Output: Scope 3 (indirect) energy used (MMBTU)	Added by GSR Team: Scope 3 (indirect) energy used (MMBTU)	Total Calculated by GSR Team
System O&M (Remedial Action Operations tab)	Consumables	80154.77	0.00	0.00	80154.77	0.00	80154.77
	Transportation-Personnel	5158.40	0.00	0.00	5158.40	1238.02	6396.42
	Transportation-Equipment	15807.08	0.00	0.00	15807.08	3793.70	19600.79
	Equipment Use and Misc	133164.96	43944.44	89220.53	0.00	0.00	133164.96
	Residual Handling	6678.35	0.00	0.00	6678.35	1602.80	8281.15
	Sub-total	240963.56	43944.44	89220.53	107798.60	6634.52	247598.08
LTM (Longterm Monitoring tab)	Consumables	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	363.73	0.00	0.00	363.73	87.30	451.03
	Transportation-Equipment	0.00	0.00	0.00	0.00	0.00	0.00
	Equipment Use and Misc	1601.88	1601.88	0.00	0.00	384.45	1986.33
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-total	1965.61	1601.88	0.00	363.73	471.75	2437.36
total		242929.17	45546.32	89220.53	108162.33	7106.27	250035.44

Note: For energy use related to fuel use for transportation or on-site equipment use, SiteWise reports energy use associated with combustion only. The added Scope 3 energy use for these activities take into account upstream energy use (i.e. energy required for extraction, refining, etc.). The added energy is based on multipliers used in the GREET software, version 1.8d.1, which in this case equates to multiplying energy used in fuel combustion by 0.24 to calculate the upstream energy use.

Electricity use reported by SiteWise in units of kWh is "Direct Scope 1", meaning it is energy consumed at the location of the project. However, energy use associated with electricity reported by SiteWise in units of MMBtu is a life-cycle value which also includes a factor to account for energy used elsewhere required to generate the electricity ("Indirect Scope 2"). Here, 33% of the life-cycle value reported by SiteWise is considered to be "Scope 1" on-site energy use, and 67% is considered to be "Scope 2" energy used in electricity generation.

GSR Team Calculations to Split GHG Results from SiteWise into "Direct" and "Indirect"
Alternative 1 - No Action (Current System)

phase	Reported by SiteWise		Assigned by GSR Team from SiteWise Output			Added by GSR Team	Total Calculated by GSR Team
			Scope 1 (direct)	Scope 2 (indirect)	Scope 3 (indirect)	Scope 3 (indirect)	
	activity	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	
System O&M (Remedial Action Operations tab)	Consumables	5303.40	0.00	0.00	5303.40	0.00	5303.40
	Transportation-Personnel	471.62	0.00	0.00	471.62	113.19	584.81
	Transportation-Equipment	1080.41	0.00	0.00	1080.41	259.30	1339.71
	Equipment Use and Misc	7501.87	0.00	5460.69	2041.19	0.00	7501.87
	Residual Handling	428.95	0.00	0.00	428.95	102.95	531.90
	Sub-total	14786.25	0.00	5460.69	9325.57	475.44	15261.69
LTM (Longterm Monitoring tab)	Consumables	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	33.26	0.00	0.00	33.26	7.98	41.24
	Transportation-Equipment	0.00	0.00	0.00	0.00	0.00	0.00
	Equipment Use and Misc	45.32	45.32	0.00	0.00	10.88	56.20
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-total	78.57	45.32	0.00	33.26	18.86	97.43
total		14864.83	45.32	5460.69	9358.82	494.29	15359.12

Note: For GHG emissions related to fuel use for transportation or on-site equipment use, SiteWise reports emissions associated with combustion only. The added Scope 3 emissions for these activities take into account upstream emissions (i.e. emissions related to extraction, refining, etc.). The added emissions factor is based on multipliers used in the GREET software, version 1.8d.1, which in this case equates to multiplying emission from fuel combustion by 0.24 to calculate the upstream emissions.

CO2e reported by SiteWise for electricity use is all associated with generation of the electricity ("Indirect Scope 2").

APPENDIX C

Supporting Information and/or Calculations for Footprinting of Other Alternatives

APPENDIX C-1

Alternative 2 – MNA

Appendix C1
Assumptions for SiteWise Input and Other Calculations
Shepley's Hill Pilot GSR Evaluation
Alternative 2 – Monitored Natural Attenuation

Alternative 2 – MNA – SiteWise "Alternative 2" Directory

- Treatment plant decommissioning
- Annual groundwater monitoring
- 100 years of operation

The notes pertaining to SiteWise input are organized by the following sections of SiteWise input:

- LTM – Uses "Longterm Monitoring" tab of SiteWise input for "SiteWise "Alternative 2"

For each section of SiteWise, all the sections are listed, with pertinent information added only for those sections of the input sheet where data were added.

Other calculations done outside of SiteWise are then presented. These include the following:

- % of total energy from renewable resources
- Hazardous Air Pollutants
- Refined Material Use
- Unrefined Material Use
- Tons of non-hazardous waste
- Risks to on-site works and from transportation
- Heavy truck trips through residential areas

Additional tables are attached which show how SiteWise outputs were split into "direct" and "indirect" energy use and greenhouse gas emissions. For definitions of direct and indirect energy use and emissions, please refer to section 2.2.2 of the evaluation report.

A cost sheet is also attached. Some of the information on the cost sheet comes from Appendix C of the December 2010 Draft FFS (also attached). Information regarding the cost calculations is as follows:

- The capital cost of $315,000 is taken from Table C-2 of the December 2010 Draft FFS. The costs mainly consist of treatment plant decommissioning and installation of additional monitoring wells, though number of wells is not specified.

- The annual cost of $150,000 for the first ten years and $100,000 for the subsequent ninety years is taken from Table C-2 of the December 2010 Draft FFS.

- Capital costs are assumed to occur in year 0, and annual costs are assumed to occur in years 1 to 100.

Alternative 2 – Description

- To determine net present value (NPV), a 2.7 percent discount rate is applied to future costs, which is consistent with the discount rate applied in the December 2010 Draft FFS.

- NPV is calculated by discounting future costs to present-day dollars using the following equation:

$$PV = \frac{FV}{(1+i)^n} = C \times FV$$

PV is the present value
FV is the value in year "n" (i.e., future value)
i is the discount rate
C is the discount factor, which equals $1/(1+i)^n$

Alternative 2 – LTM

Scope of Work (some details not outlined in the FFS are assumed)

- Treatment plant decommissioning
  - Minimal – not included in this evaluation (building will not be demolished).
- Monitoring well installation
  - Assume no new wells installed, since the December 2010 Draft FFS only states that additional wells may be installed, but does not give a specific number
- Groundwater monitoring
  - Estimated number of wells sampled and frequency of sampling based on current monitoring program. Number of wells sampled scaled up to account for price increase listed in Table C-2 of the December 2010 Draft FFS, since no reason for the increase in cost is listed.
  - Water levels at 67 monitoring wells 2 times per year
  - Water quality sampling at 43 wells in the fall and 21 wells in the spring (versus 38 wells in the fall and 16 wells in the spring in Alternative 1)
  - Low-flow sampling
  - Analytical parameters: field parameters, selected inorganic parameters, metals
  - Reduction in cost after 10 years from $150,000 to $100,000 listed in Table C-2 of December 2010 Draft FFS. Since no specific itemization for the decrease in cost is listed, it is assumed to be due to analyzing for fewer parameters and not a reduction in the number of wells sampled.

Alternative 2 – LTM

SiteWise Input – Input into "Longterm Monitoring" tab in SiteWise "Alternative 2"

- Material Production
    - Well Materials
    - Treatment Chemicals & Materials
    - GAC
    - Construction Materials
    - Well Decommissioning

- Transportation
    - Personnel Transportation – Road
        - Trip 1 – water levels (assume 3 people, 1 day, 2 times per year)
        - Trip 2 – sampling (assume 2 people, 7 days in fall and 2 people, 4 days in spring)
    - Personnel Transportation – Air
    - Personnel Transportation – Rail
    - Equipment Transportation – Road
    - Equipment Transportation – Air
    - Equipment Transportation – Rail
    - Equipment Transportation – Water

- Equipment Use
    - Earthwork
    - Drilling
    - Pump operation
    - Diesel and Gasoline Pumps
    - Blower, Compressor, Mixer, and Other Equipment
    - Generators
        - Generator 1 – Sampling pumps
            - Choose smallest generator available in Sitewise
            - Two generators, 11 (7+4) days per year, 8 hours per day, for 100 years
    - Agricultural Equipment
    - Capping Equipment
    - Mixing Equipment

- Residual Handling
    - Residue Disposal/Recycling
    - Landfill Operations
    - Thermal/Catalytic Oxidizers
    - Water Consumption
    - Landfill Methane Emissions

- Other Known On-Site Activities

Other Supporting Calculations
Shepley's Hill Landfill Pilot GSR Evaluation
Alternative 2 – MNA

% of Total Energy Usage from Renewable Resources

- None, since only energy is associated with generator

Hazardous Air Pollutants

- None for this alternative.

Refined Materials Use

- None, since all materials from alternative 1 are eliminated

Unrefined Materials Use

- None for this alternative.

Tons of Non-Hazardous Waste

- None, since all waste associated with solids handling from alternative 1 are eliminated

Risks to On-Site Workers and from Transportation

- Refer to "Total" tab of the "Summary.xlsx" spreadsheet.
- For transportation related risks, sum injuries and fatalities for all transportation activities
- Add total risk form transportation and non-transportation, and then subtract the transportation sums previously calculated, to get non-transportation.
- For this alternative, it is all transportation based.

Heavy Truck Trips through Residential Areas

- None for this alternative

Table C-1
Alternative 1 - No Action

Item	Quantity	Units	Unit Cost	Cost per Event/Year	Non-Discounted Cost	Discounted Cost
Study/Design/Capital Costs						
NONE						
Total Capital Costs					**$0**	**$0**

O & M Costs	Quantity	Units	Unit Cost	Cost per Event/Year	Non-Discounted Cost	Discounted Cost
Cap/Groundwater/LUC Monitoring						
Annual Monitoring (years 1-10)	10	years	$100,000 / yr	$100,000	$1,000,000	$866,230
Annual Monitoring (years 11-100)	90	years	$75,000 / yr	$75,000	$6,750,000	$1,934,617
Arsenic Treatment Plant						
Annual O+M	100	years	$500,000 / yr	$500,000	$50,000,000	$17,228,601
ATP Replacement Year 30	1	ea	$1,500,000 / ea	$1,500,000	$1,500,000	$674,494
APT Replacement Year 60	1	ea	$1,500,000 / ea	$1,500,000	$1,500,000	$303,295
ATP Replacement Year 90	1	ea	$1,500,000 / ea	$1,500,000	$1,500,000	$136,380
Total O&M and Monitoring Costs					**$62,250,000**	**$21,143,617**
TOTAL					**$62,250,000**	**$21,143,617**

Discount Rate for Present Value Calculations **2.7%**

Note:

Discount Rate is 30-Year Real Interest Rate from OMB Circular No. A-94 – Appendix C.

Project: GSR Pilot for Shepley's Hill Landfill
Option or Alternative: Alternative 2: MNA
Current Date: 3/4/2011

year	up-front cost	annual cost	present value of cost each year	cumulative cash flow	
		(no discounting)	2.7%	no discounting	2.7%
0	$315,000	$0	$315,000	$315,000	$315,000
1	$0	$150,000	$146,056	$465,000	$461,056
2	$0	$150,000	$142,217	$615,000	$603,273
3	$0	$150,000	$138,478	$765,000	$741,751
4	$0	$150,000	$134,837	$915,000	$876,588
5	$0	$150,000	$131,292	$1,065,000	$1,007,880
6	$0	$150,000	$127,841	$1,215,000	$1,135,721
7	$0	$150,000	$124,480	$1,365,000	$1,260,200
8	$0	$150,000	$121,207	$1,515,000	$1,381,407
9	$0	$150,000	$118,020	$1,665,000	$1,499,428
10	$0	$150,000	$114,918	$1,815,000	$1,614,345
11	$0	$100,000	$74,598	$1,915,000	$1,688,943
12	$0	$100,000	$72,636	$2,015,000	$1,761,580
13	$0	$100,000	$70,727	$2,115,000	$1,832,306
14	$0	$100,000	$68,867	$2,215,000	$1,901,174
15	$0	$100,000	$67,057	$2,315,000	$1,968,231
16	$0	$100,000	$65,294	$2,415,000	$2,033,525
17	$0	$100,000	$63,577	$2,515,000	$2,097,102
18	$0	$100,000	$61,906	$2,615,000	$2,159,008
19	$0	$100,000	$60,278	$2,715,000	$2,219,286
20	$0	$100,000	$58,694	$2,815,000	$2,277,980
21	$0	$100,000	$57,151	$2,915,000	$2,335,130
22	$0	$100,000	$55,648	$3,015,000	$2,390,779
23	$0	$100,000	$54,185	$3,115,000	$2,444,964
24	$0	$100,000	$52,761	$3,215,000	$2,497,724
25	$0	$100,000	$51,373	$3,315,000	$2,549,098
26	$0	$100,000	$50,023	$3,415,000	$2,599,121
27	$0	$100,000	$48,708	$3,515,000	$2,647,828
28	$0	$100,000	$47,427	$3,615,000	$2,695,256
29	$0	$100,000	$46,180	$3,715,000	$2,741,436
30	$0	$100,000	$44,966	$3,815,000	$2,786,402
31	$0	$100,000	$43,784	$3,915,000	$2,830,186
32	$0	$100,000	$42,633	$4,015,000	$2,872,819
33	$0	$100,000	$41,512	$4,115,000	$2,914,331
34	$0	$100,000	$40,421	$4,215,000	$2,954,752
35	$0	$100,000	$39,358	$4,315,000	$2,994,110
36	$0	$100,000	$38,323	$4,415,000	$3,032,434
37	$0	$100,000	$37,316	$4,515,000	$3,069,750
38	$0	$100,000	$36,335	$4,615,000	$3,106,084
39	$0	$100,000	$35,380	$4,715,000	$3,141,464
40	$0	$100,000	$34,449	$4,815,000	$3,175,913

Project: GSR Pilot for Shepley's Hill Landfill
Option or Alternative: Alternative 2: MNA
Current Date: 3/4/2011

year	up-front cost	annual cost	present value of cost each year	cumulative cash flow	
		(no discounting)	2.7%	no discounting	2.7%
41	$0	$100,000	$33,544	$4,915,000	$3,209,457
42	$0	$100,000	$32,662	$5,015,000	$3,242,119
43	$0	$100,000	$31,803	$5,115,000	$3,273,922
44	$0	$100,000	$30,967	$5,215,000	$3,304,889
45	$0	$100,000	$30,153	$5,315,000	$3,335,042
46	$0	$100,000	$29,360	$5,415,000	$3,364,403
47	$0	$100,000	$28,588	$5,515,000	$3,392,991
48	$0	$100,000	$27,837	$5,615,000	$3,420,828
49	$0	$100,000	$27,105	$5,715,000	$3,447,933
50	$0	$100,000	$26,392	$5,815,000	$3,474,325
51	$0	$100,000	$25,698	$5,915,000	$3,500,023
52	$0	$100,000	$25,023	$6,015,000	$3,525,046
53	$0	$100,000	$24,365	$6,115,000	$3,549,411
54	$0	$100,000	$23,724	$6,215,000	$3,573,136
55	$0	$100,000	$23,101	$6,315,000	$3,596,236
56	$0	$100,000	$22,493	$6,415,000	$3,618,730
57	$0	$100,000	$21,902	$6,515,000	$3,640,632
58	$0	$100,000	$21,326	$6,615,000	$3,661,958
59	$0	$100,000	$20,766	$6,715,000	$3,682,724
60	$0	$100,000	$20,220	$6,815,000	$3,702,943
61	$0	$100,000	$19,688	$6,915,000	$3,722,631
62	$0	$100,000	$19,170	$7,015,000	$3,741,802
63	$0	$100,000	$18,666	$7,115,000	$3,760,468
64	$0	$100,000	$18,176	$7,215,000	$3,778,644
65	$0	$100,000	$17,698	$7,315,000	$3,796,342
66	$0	$100,000	$17,233	$7,415,000	$3,813,575
67	$0	$100,000	$16,780	$7,515,000	$3,830,354
68	$0	$100,000	$16,338	$7,615,000	$3,846,692
69	$0	$100,000	$15,909	$7,715,000	$3,862,601
70	$0	$100,000	$15,491	$7,815,000	$3,878,092
71	$0	$100,000	$15,083	$7,915,000	$3,893,175
72	$0	$100,000	$14,687	$8,015,000	$3,907,862
73	$0	$100,000	$14,301	$8,115,000	$3,922,163
74	$0	$100,000	$13,925	$8,215,000	$3,936,088
75	$0	$100,000	$13,559	$8,315,000	$3,949,646
76	$0	$100,000	$13,202	$8,415,000	$3,962,849
77	$0	$100,000	$12,855	$8,515,000	$3,975,704
78	$0	$100,000	$12,517	$8,615,000	$3,988,221
79	$0	$100,000	$12,188	$8,715,000	$4,000,409
80	$0	$100,000	$11,868	$8,815,000	$4,012,276
81	$0	$100,000	$11,556	$8,915,000	$4,023,832

Project: GSR Pilot for Shepley's Hill Landfill
Option or Alternative: Alternative 2: MNA
Current Date: 3/4/2011

year	up-front cost	annual cost		present value of cost each year		cumulative cash flow	
		(no discounting)		2.7%		no discounting	2.7%
82	$0	$100,000		$11,252		$9,015,000	$4,035,084
83	$0	$100,000		$10,956		$9,115,000	$4,046,040
84	$0	$100,000		$10,668		$9,215,000	$4,056,708
85	$0	$100,000		$10,388		$9,315,000	$4,067,096
86	$0	$100,000		$10,114		$9,415,000	$4,077,210
87	$0	$100,000		$9,849		$9,515,000	$4,087,058
88	$0	$100,000		$9,590		$9,615,000	$4,096,648
89	$0	$100,000		$9,337		$9,715,000	$4,105,986
90	$0	$100,000		$9,092		$9,815,000	$4,115,078
91	$0	$100,000		$8,853		$9,915,000	$4,123,931
92	$0	$100,000		$8,620		$10,015,000	$4,132,551
93	$0	$100,000		$8,394		$10,115,000	$4,140,944
94	$0	$100,000		$8,173		$10,215,000	$4,149,117
95	$0	$100,000		$7,958		$10,315,000	$4,157,075
96	$0	$100,000		$7,749		$10,415,000	$4,164,824
97	$0	$100,000		$7,545		$10,515,000	$4,172,369
98	$0	$100,000		$7,347		$10,615,000	$4,179,716
99	$0	$100,000		$7,154		$10,715,000	$4,186,870
100	$0	$100,000		$6,966		$10,815,000	$4,193,835

Net Present Value (NPV)-> $4,193,835

*positive dollar value is a "cost", negative dollar value is a "savings"

GSR Team Calculations to Split Energy Results from SiteWise into "Direct" and "Indirect"
Alternative 2 - MNA

phase	Reported by SiteWise		Assigned by GSR Team from SiteWise Output			Added by GSR Team	Total Calculated by GSR Team
			Scope 1 (direct)	Scope 2 (indirect)	Scope 3 (indirect)	Scope 3 (indirect)	
	activity	energy used (MMBTU)	energy used (MMBTU)	energy used (MMBTU)	energy used (MMBTU)	energy used (MMBTU)	
LTM (Longterm Monitoring tab)	Consumables	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	429.87	0.00	0.00	429.87	103.17	533.03
	Transportation-Equipment	0.00	0.00	0.00	0.00	0.00	0.00
	Equipment Use and Misc	1957.85	1957.85	0.00	0.00	469.88	2427.74
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-total	2387.72	1957.85	0.00	429.87	573.05	2960.77
total		2387.72	1957.85	0.00	429.87	573.05	2960.77

Note: *For energy use related to fuel use for transportation or on-site equipment use, SiteWise reports energy use associated with combustion only. The added Scope 3 energy use for these activities take into account upstream energy use (i.e. energy required for extraction, refining, etc.). The added energy is based on multipliers used in the GREET software, version 1.8d.1, which in this case equates to multiplying energy used in fuel combustion by 0.24 to calculate the upstream energy use.*

Electricity use reported by SiteWise in units of kWh is "Direct Scope 1", meaning it is energy consumed at the location of the project. However, energy use associated with electricity reported by SiteWise in units of MMBtu is a life-cycle value which also includes a factor to account for energy used elsewhere required to generate the electricity ("Indirect Scope 2"). Here, 33% of the life-cycle value reported by SiteWise is considered to be "Scope 1" on-site energy use, and 67% is considered to be "Scope 2" energy used in electricity generation.

GSR Team Calculations to Split GHG Results from SiteWise into "Direct" and "Indirect"
Alternative 2 - MNA

phase	Reported by SiteWise: activity	Reported by SiteWise: GHG emitted (metric tons CO2e)	Assigned by GSR Team from SiteWise Output: Scope 1 (direct) GHG emitted (metric tons CO2e)	Assigned by GSR Team from SiteWise Output: Scope 2 (indirect) GHG emitted (metric tons CO2e)	Assigned by GSR Team from SiteWise Output: Scope 3 (indirect) GHG emitted (metric tons CO2e)	Added by GSR Team: Scope 3 (indirect) GHG emitted (metric tons CO2e)	Total Calculated by GSR Team
LTM (Longterm Monitoring tab)	Consumables	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	39.30	0.00	0.00	39.30	9.43	48.73
	Transportation-Equipment	0.00	0.00	0.00	0.00	0.00	0.00
	Equipment Use and Misc	55.39	55.39	0.00	0.00	13.29	68.68
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-total	94.69	55.39	0.00	39.30	22.73	117.42
total		94.69	55.39	0.00	39.30	22.73	117.42

Note: For GHG emissions related to fuel use for transportation or on-site equipment use, SiteWise reports emissions associated with combustion only. The added Scope 3 emissions for these activities take into account upstream emissions (i.e. emissions related to extraction, refining, etc.). The added emissions factor is based on multipliers used in the GREET software, version 1.8d.1, which in this case equates to multiplying emission from fuel combustion by 0.24 to calculate the upstream emissions.

CO2e reported by SiteWise for electricity use is all associated with generation of the electricity ("Indirect Scope 2").

APPENDIX C-2

Alternative 3 – P&T with Reinjection

Appendix C2
Assumptions for SiteWise Input and Other Calculations
Shepley's Hill Landfill Pilot GSR Evaluation
Alternative 3 – Pump & Treat with Reinjection

Alternative 3 – P&T with Reinjection – SiteWise "Alternative 3" Directory

- Treatment system modifications
- Installation of reinjection wells (5), trenching and piping
- Annual groundwater monitoring
- System replacement every 30 years
- 100 years of operation

The notes pertaining to SiteWise input are organized by the following sections of SiteWise input:

- Reinjection Well Installation – Uses "Remedial Investigation" tab of SiteWise input for SiteWise "Alternative 3"

- Piping and Trenching – Uses "Remedial Action Construction" tab of SiteWise input for SiteWise "Alternative 3"

- System O&M – Uses "Remedial Action Operations" tab of SiteWise input for SiteWise "Alternative 3"

- LTM – Uses "Longterm Monitoring" tab of SiteWise input for "SiteWise "Alternative 3"

For each section of SiteWise, all the sections are listed, with pertinent information added only for those sections of the input sheet where data were added.

Other calculations done outside of SiteWise are then presented. These include the following:

- % of total energy from renewable resources
- Hazardous Air Pollutants
- Refined Material Use
- Unrefined Material Use
- Tons of non-hazardous waste
- Risks to on-site works and from transportation
- Heavy truck trips through residential areas

Additional tables are attached which show how SiteWise outputs were split into "direct" and "indirect" energy use and greenhouse gas emissions. For definitions of direct and indirect energy use and emissions, please refer to section 2.2.2 of the evaluation report.

Alternative 3 – Description

A cost sheet is also attached. Some of the information on the cost sheet comes from Appendix C of the December 2010 Draft FFS (also attached). Information regarding the cost calculations is as follows:

- The capital cost of $1,160,000 is taken from Table C-3 of the December 2010 Draft FFS. The costs mainly consist of engineering and oversight for the reinjection pilot test, installation of reinjection wells, trenching and piping, and treatment system modifications.

- The annual cost of $350,000 for the first ten years and $325,000 for the subsequent ninety years is taken from Table C-3 of the December 2010 Draft FFS. Table C-3 also includes three system replacements during a 100 year period priced at $750,000 each.

- Capital costs are assumed to occur in year 0, and annual costs are assumed to occur in years 1 to 100.

- To determine net present value (NPV), a 2.7 percent discount rate is applied to future costs, which is consistent with the discount rate applied in the December 2010 Draft FFS.

- NPV is calculated by discounting future costs to present-day dollars using the following equation:

$$PV = \frac{FV}{(1+i)^n} = C \times FV$$

PV is the present value
FV is the value in year "n" (i.e., future value)
i is the discount rate
C is the discount factor, which equals $1/(1+i)^n$

Alternative 3 – Reinjection Well Installation

<u>Scope of Work (some details not outlined in the FFS are assumed)</u>

- Reinjection well installation
  - 5 injection wells, average depth of 100 ft each, 6 inch diameter, PVC casing
  - Wells installed by mud rotary drilling
  - 8 hrs of drilling per location (5 days of drilling) with a three-person crew
  - 5 additional days for pump installation and hook-up equipment use
  - Drilling cuttings and mud spread on ground near drilling locations
  - Assume PVC casing comes from 500 miles away
  - Assume cement comes from 50 miles away

- Well development
  - 1 additional day for well development
  - 1 day of 8-hours per day of operating a generator at 5HP
  - Well development water assumed to be treated at plant and not rigorously accounted for (very small relative to overall treatment volume)
- Transportation
  - Driller
    - Drill rig 20 miles one-way distance, one trip to site (one trip per week for one week)
    - Heavy support truck 20 miles one-way distance, one trip to site (one trip per week for one week)
    - Light duty vehicle 20 miles one-way distance, 5 trips to site with 3 individuals for drilling, pump installation, and well development
  - Consultant oversight
    - 20 miles one-way distance, five trips to site

Alternative 3 – Reinjection Well Installation

<u>SiteWise Input – Input into "Remedial Investigation" tab in SiteWise "Alternative 3"</u>

- Material Production
    - Well Materials
        - Well Type 1 – five 6-inch wells, 100 ft deep, PVC casing
    - Treatment Chemicals & Materials
    - GAC
    - Construction Materials
    - Well Decommissioning – "typical cement" used as a surrogate material to represent grout use for well installation
        - Well Type 1 – five 6-inch wells, 100 ft deep

- Transportation
    - Personnel Transportation – Road
        - Trip 1 – Round-trip for light truck supporting drill rig (3 individuals, daily trips for 5 days)
        - Trip 2 – Round-trip for drill rig (1 individual, weekly trips for one week, heavy duty vehicle, diesel fuel)
        - Trip 3 – Round-trip for heavy duty truck supporting drill rig (1 individual, weekly trips for one week, heavy duty vehicle, diesel fuel)
        - Trip 4 – Round-trips for consultant (1 individual, daily trips for 5 days)
    - Personnel Transportation – Air
    - Personnel Transportation – Rail
    - Equipment Transportation – Road
        - assume round-trip mileage to account for empty return trip
        - Trip 1 – Mileage and tonnage for transporting PVC for extraction wells. Calculate mileage by accounting for delivery trip and empty return trip from a distance of 500 miles (1,000 miles roundtrip). Calculate tonnage by taking weight of PVC in pounds from Material Production tab of Remedial Investigation sheet (1,765 lbs), dividing by 2000 pounds per ton (1,765/2000=0.8825), and dividing by 2 to provide an average of the tonnage for the delivery trip and empty return trip (0.8825/2=.44125).
        - Trip 2 – Mileage and tonnage for transporting cement grout for extraction wells. Calculate mileage by accounting for delivery trip and empty return trip from a distance of 50 miles (100 miles roundtrip). Calculate tonnage by taking weight of grout in kg from Material Production tab of Remedial Investigation sheet and converting it to lbs using conversion factor of 1 kg = 2.2046 lbs (4,185*2.2046=9226.251 lbs), dividing by 2000 pounds per ton (9226.251/2000=4.6131), and dividing by 2 to provide an average of the tonnage for the delivery trip and empty return trip (4.6131/2=2.3066).
    - Equipment Transportation – Air
    - Equipment Transportation – Rail
    - Equipment Transportation – Water

- Equipment Use
    - Earthwork
    - Drilling
        - Event 1 – five 6-inch wells, 100 ft deep, mud rotary, 8 hours per well

Alternative 3 – Reinjection Well Installation

  - Pump operation
  - Diesel and Gasoline Pumps
  - Blower, Compressor, Mixer, and Other Equipment
  - Generators
    - Generator 1 – operate well development pumps
      - Choose smallest generator available in SiteWise
      - Running for 8 hours total (1 day)
  - Agricultural Equipment
  - Capping Equipment
  - Mixing Equipment

- Residual Handling
  - Residue Disposal/Recycling
  - Landfill Operations
  - Thermal/Catalytic Oxidizers
  - Water Consumption
  - Landfill Methane Emissions

- Other Known On-Site Activities
  - Water from redevelopment not specified it is mimimal

Alternative 3 – Piping and Trenching

Scope of Work (some details not outlined in the FFS are assumed)

- Install piping following piping lengths approximated from Figure 8 of the December 2010 Draft FFS. Assume a total of 1,000 ft of piping, accounting for distance to treatment plant and connections between injection wells.
- Trench volume is calculated for “earthwork” portion of input for excavator use, which requires cubic yards for input. The trench volume is calculated as length multiplied by x-section area, then divide by 27 to convert from cubic feet to cubic yards.
- For construction materials portion of input, SiteWise only has HDPE in units of volume, not length of pipe. Therefore, need to calculate HDPE mass and use density of 0.946 g/cc = 58.9 lbs/cf to calculate volume of HDPE for input.

Size	Length (ft)	HDPE (lbs/ft)	Trench X-Sect. Area (ft2)	Trench Volume (cy)	HDPE Mass (lbs)
6-inch	1,000	5	10	370	5,000
					85 ft^3

*5,000 lbs * 1cf/58.9 lbs = 85 cf for volume of HDPE*

- Bedding and back fill with native fill
- Excavation and backfill assumed to be done by hydraulic excavator. Number of crew days for work is assumed to be approximately equal to the total hours of equipment operation calculated by SiteWise divided by 8 hours per day. Crew is assumed to be 2 individuals.
- Productivity rate for laying pipe is assumed to be approximately 250 feet per day for a crew of 4.
- Equipment – assume one trip to site for the following equipment
    - 1 excavator
    - 1 loader
    - Heat fusers and equipment for lifting and pulling pipe is excluded

- Oversight consultant (1 individual riding in a light duty truck)
    - Daily trips (4 trips), 20 miles one-way

- HDPE SDR 11 pipe transported from 500 miles from site (assumed generic distance)

Alternative 3 – Piping and Trenching

<u>SiteWise Input – Input into “Remedial Action Construction” tab of SiteWise “Alternative 3”</u>

- Material Production
  - Well Materials
  - Treatment Chemicals & Materials
  - GAC
  - Construction Materials
    - Material 1 – HDPE for reinjection system piping. Assuming 1,000 ft of piping. At 5lbs/ft, HDPE mass in lbs=5,000 lbs (1,000*5). At 58.9 lbs/cf, volume of HDPE = 85 cf (5,000/58.9)
  - Well Decommissioning

- Transportation
  - Personnel Transportation – Road
    - All personnel assumed to be local (~20 miles one way, 40 miles round trip)
    - Trip 1 – Round-trips for 4 person pipe-laying crew calculated by taking 1,000 feet of piping and dividing by productivity rate of 250 feet per day (1,000/250=4).
    - Trip 2 – Round-trips for 2 person excavation and backfill crew. Number of trips calculated by taking total number of equipment operation hours from SiteWise Remedial Action Construction output file, Equipment Use – Earthwork sheet (5.4+5.4=10.8) and dividing by 8 hours per day and rounding result as appropriate (~2 days).
    - Trip 3 – Round-trips for heavy equipment (one round-trip per piece of equipment and two pieces of equipment). Select “heavy duty” for vehicle type and diesel for fuel used.
    - Trip 4 – Round-trips for consultant on a daily basis for 4 days.
  - Personnel Transportation – Air
  - Personnel Transportation – Rail
  - Equipment Transportation – Road
    - assume round-trip mileage to account for empty return trip
    - Trip 1 – Mileage and tonnage for transporting HDPE for reinjection system. Assumes distance of 500 miles for shipping, plus an empty return trip for a total of 1,000 miles per trip. Tonnage is equal to the total weight hauled (5,000 lbs) divided by 2,000 to convert to tons (5,000/2,000=2.5), divided by 2 to provide an average of the tonnage for the delivery trip and empty return trip (2.5/2=1.25).
  - Equipment Transportation – Air
  - Equipment Transportation – Rail
  - Equipment Transportation – Water

- Equipment Use – Equipment use is a hydraulic excavator for excavation and backfill of the trench. SiteWise determines the equipment horsepower and bucket size based on total cubic yards excavated. Although this may be appropriate for single, large excavation, it is not necessarily appropriate for trenching. In addition, the productivity rates provided in SiteWise for excavator use do not agree with those provided by RS Means construction data. The Look Up Table in SiteWise Input Sheet.xls was modified to provide a consistent and appropriate equipment size for all trenching. Productivity rates were also updated to be consistent with RS Means construction data.

- Earthwork
  - Equipment 1 – Excavator for reinjection system trenching. The trench volume is calculated as length (1,000 ft) multiplied by x-section area (assumed to be 10 ft^2), then divide by 27 to convert from cubic feet to cubic yards (1,000*10/27).
  - Equipment 2 – Excavator used instead of loader (to utilize lookup table modification described above) for reinjection system backfill. The volume of backfill is assumed to be approximately equal to the trench volume calculated above.
- Drilling
- Pump operation
- Diesel and Gasoline Pumps
- Blower, Compressor, Mixer, and Other Equipment
- Generators
- Agricultural Equipment
- Capping Equipment
- Mixing Equipment

- Residual Handling
  - Residue Disposal/Recycling
  - Landfill Operations
  - Thermal/Catalytic Oxidizers
  - Water Consumption
  - Landfill Methane Emissions

- Other Known On-Site Activities

Alternative 3 – System O&M

Scope of Work (some details not outlined in the FFS are assumed)

According to the FFS, the modified treatment plant will "reduce overall operation and maintenance costs by approximately 50% and significantly decrease sludge generation, chemical usage, and energy usage". The modified system will include:

- The existing extraction wells would operate at the original design rate of 44-50 gpm.

- A solid filtration media, such as a sand filter, would be used to remove an estimated 20-40% of the arsenic in groundwater. This system would include methods for backwashing the filtration media.

- Filtered groundwater would then be injected into the aquifer sands beneath the landfill. Each injection well is assumed to pump at 10 gpm, for a total of 50 gpm.

- Water would also require chemical conditioning to remove oxygen prior to injection.

System O&M for this alternative is based on current treatment plant operations, with some modifications and additions as outlined in the December 2010 Draft FFS. Where specific details were not given in the FFS, reasonable assumptions were made. These assumptions can be corrected or refined as new information becomes available.

- Extraction pumps
  - 2 extraction wells, each with 5 HP electric submersible pump with a VFD; VFD frequency for typical pump operation = 33 Hz (at time of RSE), or half of the pump's rated speed
  - Both wells 6 inches in diameter, 88 ft and 98 ft deep, with 25-ft screen intervals
  - Maximum system flow rate = 50 gpm combined for two wells, average flow rate over the course of the month = ~42 gpm due to downtime associated with system backwashes (at time of RSE). RSE estimated future operating rate of **45 gpm**
  - Assume pumps operate for 100 yrs = 876,000 hrs.
- Treatment system
  - Sand filter with backwash
  - Reduced waste generation
- Reinjection system
  - 5 injection wells, each pumping at 10 gpm for a total of 50 gpm
  - Each well is assumed to be 6 inches in diameter and 100 ft deep
  - ~1000 ft of 4-inch HDPE piping from treatment plant to injection wells
- Annual electricity usage for currently operating P&T system (from utility bills) includes an additional 6,000 kWh per month from December through May for electric heating. It is assumed that the same amount of electricity will be needed for heating the modified heating plant in this alternative.
- With treatment plant modifications, assumed ~8 hrs of labor billed to site each week
- System replacement every 30 years
  - The specific materials, equipment, and labor hours required are unknown. Therefore, detailed footprinting using SiteWise was not done for this component of this remedial alternative.

Alternative 3 – System O&M

- Based on *U.S. Carbon Dioxide Emissions and Intensities Over Time: A Detailed Accounting of Industries, Government and Households* (April 2010), approximately 1 lb (0.00045 metric tons) of CO2 is emitted per dollar of United States GDP. In the absence of other information, it is assumed that the specified activity also has an emission profile of approximately 1 lb of CO2 emitted per dollar of cost. This emission is likely based on a mix of fuel uses and activities.
- The non-discounted cost for the three system replacements over the course of 100 years of remedy operation is estimated at $750,000 each, for a total cost of $2,250,000. This would lead to the emission of approximately 2,250,000 lbs of CO2, or 1021 metric tons of CO2.

Alternative 3 – System O&M

SiteWise Input – Input into "Remedial Action Operations" tab in SiteWise "Alternative 3"

- Material Production
    - Well Materials
    - Treatment Chemicals & Materials
        - Sand for sand filter is a negligible amount and is therefore not included
        - The chemical conditioning to remove oxygen prior to reinjection cannot be quantified at this time and is therefore not included
    - GAC
    - Construction Materials
    - Well Decommissioning

- Transportation
    - Personnel Transportation – Road
        - Trip 1 – 1 round-trip per week for operator, 52 weeks per year, for 100 years of plant operation
    - Personnel Transportation – Air
    - Personnel Transportation – Rail
    - Equipment Transportation – Road
    - Equipment Transportation – Air
    - Equipment Transportation – Rail
    - Equipment Transportation – Water

- Equipment Use
    - Earthwork
    - Drilling
    - Pump operation (use method 3, electricity zone NEWE)
        - Pump 1 – 2 extraction well pumps (VFDs)
            - HP = $(5*0.5^3)/0.8 = 0.78$ (see VFD formula in introduction) for Alternative 1. For this alternative, assume VFD setting will be higher than 0.5 to push water thru sand filter, set at 0.6. Thus, HP for each pump will be $(5*0.6^3)/0.8 = 1.35$. Set pump load to 1
            - Use 70% efficiency for 5HP submersible pump motor
        - Pump 2 – Backwash pump
            - Assume same backwash pump as alternative 1, but much less frequent operation (assume 4x per day for 2 minutes each backwash with VFD set at 59%
            - 8 mins/day * 365 day/yr * 100 yrs * 1hr/60 mins = 4867 hrs
            - HP = $(3*.59^3)/0.8 = 0.77$ HP, pump load = 1
            - Use 70% efficiency for small above-ground pump motor
        - Pump 3 – Assume 2 alternating 1 HP pumps for discharge to reinjection system (one operating), rather than 5HP pumps in Alternative 1, since less HP should be need to reinject water a short distance from the plant
            - 1 HP, load = 0.85, efficiency 0.7, for 24*365*100 = 876,000 hrs
    - Diesel and Gasoline Pumps
    - Blower, Compressor, Mixer, and Other Equipment

Alternative 3 – System O&M

        - Equipment 1 (method 2, other) – Electric resistive heater for treatment plant freeze protection. 6,000 kWh per month for six months per year for 100 years.
        - Region – Select "NEWE" for eGRID subregion that includes Massachusetts
    - Generators
    - Agricultural Equipment
    - Capping Equipment
    - Mixing Equipment

- Residual Handling
    - Residue Disposal/Recycling
        - Other Residuals – 6 trips per year (assuming a 70% reduction in waste generation from the current treatment plant) for 100 years to dispose of solids generated from treatment (172 miles round-trip to Turnkey Landfill). Weight of 9 tons per delivery to landfill. In SiteWise, average delivery trip and empty return trip is 9 tons/2 = 4.5 tons per round trip. Use heavy duty truck, diesel.
    - Landfill Operations
    - Thermal/Catalytic Oxidizers
    - Water Consumption
    - Landfill Methane Emissions

- Other Known On-Site Activities
    - CO_2 Emissions – System replacements. The non-discounted cost for the three treatment plant replacements over the course of 100 years of remedy operation is estimated at $750,000 each, for a total cost of $2,250,000. This would lead to the emission of approximately 2,225,000 lbs of CO_2, or 1021 metric tons of CO_2.

Alternative 3 – LTM

Scope of Work (some details not outlined in the FFS are assumed)

- Groundwater monitoring
    - Water levels at 67 monitoring wells 2 times per year
    - Water quality sampling at 38 wells in the fall and 16 wells in the spring
    - Low-flow sampling
    - Analytical parameters: field parameters, selected inorganic parameters, metals
    - Reduction in cost after 10 years from $100,000 to $75,000 listed in Table C-3 of December 2010 Draft FFS. Since no reason for the decrease in cost is listed, it is assumed to be due to analyzing for fewer parameters and not a reduction in the number of wells sampled.
- Process monitoring
    - Effluent sampled 4 times per year for metals and other parameters
    - Effluent sampled 1 time per year for VOCs, SVOCs, and pesticides
    - Influent sampled 1 time per year for VOCs

Alternative 3 – LTM

<u>SiteWise Input – Input into "Longterm Monitoring" tab in SiteWise "Alternative 3"</u>

- Material Production
  - Well Materials
  - Treatment Chemicals & Materials
  - GAC
  - Construction Materials
  - Well Decommissioning

- Transportation
  - Personnel Transportation – Road
    - Trip 1 – water levels (assume 3 people, 1 day, 2 times per year)
    - Trip 2 – sampling (assume 2 people, 6 days in fall and 2 people, 3 days in spring)
    - Note – influent and effluent sampling assumed to be conducted by plant operator and requires no extra trip
  - Personnel Transportation – Air
  - Personnel Transportation – Rail
  - Equipment Transportation – Road
  - Equipment Transportation – Air
  - Equipment Transportation – Rail
  - Equipment Transportation – Water

- Equipment Use
  - Earthwork
  - Drilling
  - Pump operation
  - Diesel and Gasoline Pumps
  - Blower, Compressor, Mixer, and Other Equipment
  - Generators
    - Generator 1 – Sampling pumps
      - Choose smallest generator available in SiteWise
      - Two generators, 9 (6+3) days per year, 8 hours per day, for 100 years
  - Agricultural Equipment
  - Capping Equipment
  - Mixing Equipment

- Residual Handling
  - Residue Disposal/Recycling
  - Landfill Operations
  - Thermal/Catalytic Oxidizers
  - Water Consumption
  - Landfill Methane Emissions

- Other Known On-Site Activities

Other Supporting Calculations
Shepley's Hill Landfill Pilot GSR Evaluation
Alternative 3 – P&T with Reinjection

% of Total Energy Usage from Renewable Resources

- From SiteWise "Summary.xlsx" sheet, total energy usage is 78,000 MMBtu
- Only renewable are from electricity , which I sasscoiated with O&M (i.e., Remedial Action Operations.xlsx in SiteWise). From SiteWise "Summary" tab of "Remedial Action Operations.xlsx" sheet, energy from "Equipment Use & Misc" is 72,000 MMBtu. For this alternative, all equipment use in this cell is electricity use (includes pumps heater). Note that this is not necessarily the case for other alternatives or projects.
- 72,000/78,000 = 92% of energy use is electricity
- From www.epa.gov/egrid, generation mix for NEWE subregion is 11.3% renewable resources, mostly hydro (including large hydro) and biomass
- 92%*11.3% = 10.4% of total energy use is from renewable resources

Hazardous Air Pollutants

- None for this alternative.

Refined Materials Use

- 1,765 pounds of PVC (from SiteWise) for new wells
- 4,185 kg cement (substitute for grout) from SiteWise for well drilling = 9,207 pounds (4185*2.2)
- 2,294 kg HDPE (from SiteWise) for piping = 5,047 pounds (2294*2.2)

Unrefined Materials Use

- None for this alternative.

Tons of Non-Hazardous Waste

- Solids from filter bottom - 9 tons of waste 6 times per year for 100 years = 5,400 tons

Risks to On-Site Workers and from Transportation

- Refer to "Total" tab of the "Summary.xlsx" spreadsheet.
- For transportation related risks, sum injuries and fatalities for all transportation activities
- Add total risk form transportation and non-transportation, and then subtract the transportation sums previously calculated, to get non-transportation.
- For this alternative, nearly all safety risk (0.27) is transportation based, with a very minor contribution (0.001) from equipment use associated with well drilling and laying pipe.

Alternative 3 – Other Calculations

Heavy Truck Trips through Residential Areas

- Project team indicated that trucks could enter through a non-residential route.

Table C-3
Alternative 3 - Groundwater Extraction/Recirculation System

Item	Quantity	Units	Unit Cost	Cost per Event/Year	Non-Discounted Cost	Discounted Cost
Study/Design/Capital Costs						
Design						
Reinjection Pilot Test	1	job	$60,000 / job	$60,000	$60,000	$60,000
Engineering & Oversight	1	job	$200,000 / job	$200,000	$200,000	$200,000
Installation						
Installation of reinjection wells, trenching and piping	1	job	$350,000 / job	$350,000	$350,000	$350,000
Treatment system modifications	1	job	$400,000 / job	$400,000	$400,000	$400,000
Contingency	1	job	20%	$150,000	$150,000	$150,000
Total Capital Costs					**$1,160,000**	**$1,160,000**

O & M Costs	Quantity	Units	Unit Cost	Cost per Event/Year	Non-Discounted Cost	Discounted Cost
Cap/Groundwater/LUC Monitoring						
Annual Monitoring (years 1-10)	10	years	$100,000 / yr	$100,000	$1,000,000	$866,230
Annual Monitoring (years 11-100)	90	years	$75,000 / yr	$75,000	$6,750,000	$1,934,617
Extraction/Recirculation System						
Annual O+M	100	years	$250,000 / yr	$250,000	$25,000,000	$8,614,301
System Replacement Year 30	1	ea	$750,000 / ea	$750,000	$750,000	$337,247
System Replacement Year 60	1	ea	$750,000 / ea	$750,000	$750,000	$151,647
System Replacement Year 90	1	ea	$750,000 / ea	$750,000	$750,000	$68,190
Total O&M and Monitoring Costs					**$35,000,000**	**$11,972,233**
TOTAL					**$36,160,000**	**$13,132,233**

Discount Rate for Present Value Calculations **2.7%**

Note:

Discount Rate is 30-Year Real Interest Rate from OMB Circular No. A-94 – Appendix C.

Project: GSR Pilot for Shepley's Hill Landfill
Option or Alternative: Alternative 3: P&T with Reinjection
Current Date: 3/4/2011

year	up-front cost	annual cost	present value of cost each year	cumulative cash flow	
		(no discounting)	2.7%	no discounting	2.7%
0	$1,160,000	$0	$1,160,000	$1,160,000	$1,160,000
1	$0	$350,000	$340,798	$1,510,000	$1,500,798
2	$0	$350,000	$331,839	$1,860,000	$1,832,637
3	$0	$350,000	$323,115	$2,210,000	$2,155,752
4	$0	$350,000	$314,620	$2,560,000	$2,470,372
5	$0	$350,000	$306,349	$2,910,000	$2,776,720
6	$0	$350,000	$298,295	$3,260,000	$3,075,015
7	$0	$350,000	$290,452	$3,610,000	$3,365,467
8	$0	$350,000	$282,816	$3,960,000	$3,648,284
9	$0	$350,000	$275,381	$4,310,000	$3,923,665
10	$0	$350,000	$268,141	$4,660,000	$4,191,806
11	$0	$325,000	$242,442	$4,985,000	$4,434,248
12	$0	$325,000	$236,068	$5,310,000	$4,670,317
13	$0	$325,000	$229,862	$5,635,000	$4,900,179
14	$0	$325,000	$223,819	$5,960,000	$5,123,998
15	$0	$325,000	$217,935	$6,285,000	$5,341,933
16	$0	$325,000	$212,205	$6,610,000	$5,554,138
17	$0	$325,000	$206,626	$6,935,000	$5,760,765
18	$0	$325,000	$201,194	$7,260,000	$5,961,959
19	$0	$325,000	$195,905	$7,585,000	$6,157,864
20	$0	$325,000	$190,754	$7,910,000	$6,348,618
21	$0	$325,000	$185,739	$8,235,000	$6,534,357
22	$0	$325,000	$180,856	$8,560,000	$6,715,214
23	$0	$325,000	$176,102	$8,885,000	$6,891,315
24	$0	$325,000	$171,472	$9,210,000	$7,062,787
25	$0	$325,000	$166,964	$9,535,000	$7,229,751
26	$0	$325,000	$162,574	$9,860,000	$7,392,325
27	$0	$325,000	$158,300	$10,185,000	$7,550,625
28	$0	$325,000	$154,138	$10,510,000	$7,704,764
29	$0	$325,000	$150,086	$10,835,000	$7,854,850
30	$0	$1,075,000	$483,387	$11,910,000	$8,338,237
31	$0	$325,000	$142,298	$12,235,000	$8,480,535
32	$0	$325,000	$138,557	$12,560,000	$8,619,093
33	$0	$325,000	$134,915	$12,885,000	$8,754,007
34	$0	$325,000	$131,368	$13,210,000	$8,885,375
35	$0	$325,000	$127,914	$13,535,000	$9,013,289
36	$0	$325,000	$124,551	$13,860,000	$9,137,840
37	$0	$325,000	$121,277	$14,185,000	$9,259,116
38	$0	$325,000	$118,088	$14,510,000	$9,377,204
39	$0	$325,000	$114,984	$14,835,000	$9,492,188
40	$0	$325,000	$111,961	$15,160,000	$9,604,149

Project: GSR Pilot for Shepley's Hill Landfill
Option or Alternative: Alternative 3: P&T with Reinjection
Current Date: 3/4/2011

year	up-front cost	annual cost	present value of cost each year	cumulative cash flow	
		(no discounting)	2.7%	no discounting	2.7%
41	$0	$325,000	$109,017	$15,485,000	$9,713,166
42	$0	$325,000	$106,151	$15,810,000	$9,819,317
43	$0	$325,000	$103,360	$16,135,000	$9,922,678
44	$0	$325,000	$100,643	$16,460,000	$10,023,321
45	$0	$325,000	$97,997	$16,785,000	$10,121,318
46	$0	$325,000	$95,421	$17,110,000	$10,216,739
47	$0	$325,000	$92,912	$17,435,000	$10,309,651
48	$0	$325,000	$90,469	$17,760,000	$10,400,120
49	$0	$325,000	$88,091	$18,085,000	$10,488,211
50	$0	$325,000	$85,775	$18,410,000	$10,573,986
51	$0	$325,000	$83,520	$18,735,000	$10,657,506
52	$0	$325,000	$81,324	$19,060,000	$10,738,831
53	$0	$325,000	$79,186	$19,385,000	$10,818,017
54	$0	$325,000	$77,104	$19,710,000	$10,895,121
55	$0	$325,000	$75,077	$20,035,000	$10,970,199
56	$0	$325,000	$73,104	$20,360,000	$11,043,302
57	$0	$325,000	$71,182	$20,685,000	$11,114,484
58	$0	$325,000	$69,310	$21,010,000	$11,183,794
59	$0	$325,000	$67,488	$21,335,000	$11,251,282
60	$0	$1,075,000	$217,361	$22,410,000	$11,468,643
61	$0	$325,000	$63,986	$22,735,000	$11,532,630
62	$0	$325,000	$62,304	$23,060,000	$11,594,934
63	$0	$325,000	$60,666	$23,385,000	$11,655,600
64	$0	$325,000	$59,071	$23,710,000	$11,714,671
65	$0	$325,000	$57,518	$24,035,000	$11,772,189
66	$0	$325,000	$56,006	$24,360,000	$11,828,195
67	$0	$325,000	$54,534	$24,685,000	$11,882,728
68	$0	$325,000	$53,100	$25,010,000	$11,935,828
69	$0	$325,000	$51,704	$25,335,000	$11,987,532
70	$0	$325,000	$50,345	$25,660,000	$12,037,876
71	$0	$325,000	$49,021	$25,985,000	$12,086,897
72	$0	$325,000	$47,732	$26,310,000	$12,134,630
73	$0	$325,000	$46,477	$26,635,000	$12,181,107
74	$0	$325,000	$45,255	$26,960,000	$12,226,362
75	$0	$325,000	$44,066	$27,285,000	$12,270,428
76	$0	$325,000	$42,907	$27,610,000	$12,313,335
77	$0	$325,000	$41,779	$27,935,000	$12,355,114
78	$0	$325,000	$40,681	$28,260,000	$12,395,795
79	$0	$325,000	$39,611	$28,585,000	$12,435,406
80	$0	$325,000	$38,570	$28,910,000	$12,473,976
81	$0	$325,000	$37,556	$29,235,000	$12,511,532

Project: GSR Pilot for Shepley's Hill Landfill
Option or Alternative: Alternative 3: P&T with Reinjection
Current Date: 3/4/2011

year	up-front cost	annual cost	present value of cost each year	cumulative cash flow	
		(no discounting)	2.7%	no discounting	2.7%
82	$0	$325,000	$36,568	$29,560,000	$12,548,100
83	$0	$325,000	$35,607	$29,885,000	$12,583,707
84	$0	$325,000	$34,671	$30,210,000	$12,618,378
85	$0	$325,000	$33,759	$30,535,000	$12,652,138
86	$0	$325,000	$32,872	$30,860,000	$12,685,010
87	$0	$325,000	$32,008	$31,185,000	$12,717,018
88	$0	$325,000	$31,166	$31,510,000	$12,748,184
89	$0	$325,000	$30,347	$31,835,000	$12,778,531
90	$0	$1,075,000	$97,739	$32,910,000	$12,876,270
91	$0	$325,000	$28,772	$33,235,000	$12,905,042
92	$0	$325,000	$28,016	$33,560,000	$12,933,058
93	$0	$325,000	$27,279	$33,885,000	$12,960,337
94	$0	$325,000	$26,562	$34,210,000	$12,986,899
95	$0	$325,000	$25,864	$34,535,000	$13,012,763
96	$0	$325,000	$25,184	$34,860,000	$13,037,947
97	$0	$325,000	$24,522	$35,185,000	$13,062,468
98	$0	$325,000	$23,877	$35,510,000	$13,086,345
99	$0	$325,000	$23,249	$35,835,000	$13,109,595
100	$0	$325,000	$22,638	$36,160,000	$13,132,233

Net Present Value (NPV)-> $13,132,233

*positive dollar value is a "cost", negative dollar value is a "savings"

GSR Team Calculations to Split Energy Results from SiteWise into "Direct" and "Indirect"
Alternative 3 - P&T with Reinjection

phase	Reported by SiteWise: activity	Reported by SiteWise: energy used (MMBTU)	Assigned by GSR Team from SiteWise Output: Scope 1 (direct) energy used (MMBTU)	Assigned by GSR Team from SiteWise Output: Scope 2 (indirect) energy used (MMBTU)	Assigned by GSR Team from SiteWise Output: Scope 3 (indirect) energy used (MMBTU)	Added by GSR Team: Scope 3 (indirect) energy used (MMBTU)	Total Calculated by GSR Team
Reinjection Well Installation (Remedial Investigation tab)	Consumables	69.46	0.00	0.00	69.46	0.00	69.46
	Transportation-Personnel	4.70	0.00	0.00	4.70	1.13	5.82
	Transportation-Equipment	19.23	0.00	0.00	19.23	4.62	23.85
	Equipment Use and Misc	79.01	79.01	0.00	0.00	18.96	97.97
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-total	172.40	79.01	0.00	93.40	24.71	197.11
Piping and Trenching (Remedial Action Construction tab)	Consumables	225.84	0.00	0.00	225.84	0.00	225.84
	Transportation-Personnel	4.70	0.00	0.00	4.70	1.13	5.82
	Transportation-Equipment	17.64	0.00	0.00	17.64	4.23	21.88
	Equipment Use and Misc	21.20	21.20	0.00	0.00	5.09	26.29
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-total	269.38	21.20	0.00	248.18	10.45	279.83
System O&M (Remedial Action Operations tab)	Consumables	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	1719.47	0.00	0.00	1719.47	412.67	2132.14
	Transportation-Equipment	0.00	0.00	0.00	0.00	0.00	0.00
	Equipment Use and Misc	71518.66	23601.16	47917.50	0.00	0.00	71518.66
	Residual Handling	1908.10	0.00	0.00	1908.10	457.94	2366.04
	Sub-total	75146.22	23601.16	47917.50	3627.57	870.62	76016.84
LTM (Longterm Monitoring tab)	Consumables	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	363.73	0.00	0.00	363.73	87.30	451.03
	Transportation-Equipment	0.00	0.00	0.00	0.00	0.00	0.00
	Equipment Use and Misc	1601.88	1601.88	0.00	0.00	384.45	1986.33
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-total	1965.61	1601.88	0.00	363.73	471.75	2437.36
total		77553.62	25303.25	47917.50	4332.87	1377.52	78931.14

Note: *For energy use related to fuel use for transportation or on-site equipment use, SiteWise reports energy use associated with combustion only. The added Scope 3 energy use for these activities take into account upstream energy use (i.e. energy required for extraction, refining, etc.). The added energy is based on multipliers used in the GREET software, version 1.8d.1, which in this case equates to multiplying energy used in fuel combustion by 0.24 to calculate the upstream energy use.*

Electricity use reported by SiteWise in units of kWh is "Direct Scope 1", meaning it is energy consumed at the location of the project. However, energy use associated with electricity reported by SiteWise in units of MMBtu is a life-cycle value which also includes a factor to account for energy used elsewhere required to generate the electricity ("Indirect Scope 2"). Here, 33% of the life-cycle value reported by SiteWise is considered to be "Scope 1" on-site energy use, and 67% is considered to be "Scope 2" energy used in electricity generation.

GSR Team Calculations to Split GHG Results from SiteWise into "Direct" and "Indirect"
Alternative 3 - P&T with Reinjection

phase	Reported by SiteWise activity	Reported by SiteWise GHG emitted (metric tons CO2e)	Assigned by GSR Team from SiteWise Output Scope 1 (direct) GHG emitted (metric tons CO2e)	Assigned by GSR Team from SiteWise Output Scope 2 (indirect) GHG emitted (metric tons CO2e)	Assigned by GSR Team from SiteWise Output Scope 3 (indirect) GHG emitted (metric tons CO2e)	Added by GSR Team Scope 3 (indirect) GHG emitted (metric tons CO2e)	Total Calculated by GSR Team
Reinjection Well Installation (Remedial Investigation tab)	Consumables	5.96	0.00	0.00	5.96	0.00	5.96
	Transportation-Personnel	0.40	0.00	0.00	0.40	0.10	0.49
	Transportation-Equipment	1.31	0.00	0.00	1.31	0.316	1.63
	Equipment Use and Misc	5.78	5.78	0.00	0.00	1.39	7.17
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-total	13.46	5.78	0.00	7.67	1.80	15.25
Piping and Trenching (Remedial Action Construction tab)	Consumables	5.96	0.00	0.00	5.96	0.00	5.96
	Transportation-Personnel	0.40	0.00	0.00	0.40	0.10	0.49
	Transportation-Equipment	1.21	0.00	0.00	1.21	0.29	1.50
	Equipment Use and Misc	1.30	1.30	0.00	0.00	0.31	1.61
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-total	8.86	1.30	0.00	7.57	0.70	9.56
System O&M (Remedial Action Operations tab)	Consumables	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	157.21	0.00	0.00	157.21	37.73	194.94
	Transportation-Equipment	0.00	0.00	0.00	0.00	0.00	0.00
	Equipment Use and Misc	3953.35	0.00	2932.76	1020.59	0.00	3953.35
	Residual Handling	122.56	0.00	0.00	122.56	29.41	151.97
	Sub-total	4233.12	0.00	2932.76	1300.36	67.14	4300.26
LTM (Longterm Monitoring tab)	Consumables	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	33.26	0.00	0.00	33.26	7.98	41.24
	Transportation-Equipment	0.00	0.00	0.00	0.00	0.00	0.00
	Equipment Use and Misc	45.32	45.32	0.00	0.00	10.88	56.20
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-total	78.57	45.32	0.00	33.26	18.86	97.43
total		4334.01	52.40	2932.76	1348.85	88.50	4422.51

Note: For GHG emissions related to fuel use for transportation or on-site equipment use, SiteWise reports emissions associated with combustion only. The added Scope 3 emissions for these activities take into account upstream emissions (i.e. emissions related to extraction, refining, etc.). The added emissions factor is based on multipliers used in the GREET software, version 1.8d.1, which in this case equates to multiplying emission from fuel combustion by 0.24 to calculate the upstream emissions.

CO2e reported by SiteWise for electricity use is all associated with generation of the electricity ("Indirect Scope 2").

APPENDIX C-3

Alternative 4 – PRB

Appendix C3
Assumptions for SiteWise Input and Other Calculations
Shepley's Hill Pilot GSR Evaluation
Alternative 4 – Permeable Reactive Barrier

Alternative 4 – PRB – SiteWise "Alternative 4" Directory

- Installation of a 400' long x 6' wide permeable reactive barrier to replace the P&T system
- Disposal of excavated material under the landfill cap
- Annual groundwater monitoring (same as Alternative 1)
- Wall redevelopment every 5 years
- 100 years of operation

The notes pertaining to SiteWise input are organized by the following sections of SiteWise input:

- PRB Installation and Disposal of Excavated Material – Uses "Remedial Action Construction" tab of SiteWise input for SiteWise "Alternative 4"

- System O&M – Uses "Remedial Action Operations" tab of SiteWise input for SiteWise "Alternative 4"

- LTM – Uses "Longterm Monitoring" tab of SiteWise input for "SiteWise "Alternative 4"

For each section of SiteWise, all the sections are listed, with pertinent information added only for those sections of the input sheet where data were added.

Other calculations done outside of SiteWise are then presented. These include the following:

- % of total energy from renewable resources
- Hazardous Air Pollutants
- Refined Material Use
- Unrefined Material Use
- Tons of non-hazardous waste
- Risks to on-site works and from transportation
- Heavy truck trips through residential areas

Additional tables are attached which show how SiteWise outputs were split into "direct" and "indirect" energy use and greenhouse gas emissions. For definitions of direct and indirect energy use and emissions, please refer to section 2.2.2 of the evaluation report.

A cost sheet is also attached. Some of the information on the cost sheet comes from Appendix C of the December 2010 Draft FFS (also attached). Information regarding the cost calculations is as follows:

- The capital cost of $12,777,351 is taken from Table C-4 of the December 2010 Draft FFS. The costs mainly consist of engineering and oversight for system design, installation of the PRB, materials for the PRB, and disposal of excavated materials under the landfill cap.

- The annual cost of $115,000 for the first ten years and $90,000 for the subsequent ninety years is taken from Table C-4 of the December 2010 Draft FFS. Table C-4 also includes wall redevelopment every 5 years during a 100 year period priced at $40,000 per event.

- Capital costs are assumed to occur in year 0, and annual costs are assumed to occur in years 1 to 100.

- To determine net present value (NPV), a 2.7 percent discount rate is applied to future costs, which is consistent with the discount rate applied in the December 2010 Draft FFS.

- NPV is calculated by discounting future costs to present-day dollars using the following equation:

$$PV = \frac{FV}{(1+i)^n} = C \times FV$$

PV is the present value
FV is the value in year “n” (i.e., future value)
i is the discount rate
C is the discount factor, which equals $1/(1+i)^n$

Alternative 4 – PRB Installation and Disposal of Excavated Material

<u>Scope of Work (some details not outlined in the FFS are assumed)</u>

- PRB installation
  - Table C-4 says PRB will be 42,800 ft^2 (length*depth) and 6 ft wide, so excavation volume is 256,800 ft^3
  - Will require sheet pile steel, assume sheet piling and bracing temporary (i.e., not permanent).
  - 6,000 tons of iron and 4,667 tons of sand required for wall
- Installation will require sheet pile steel, assume sheet piling and bracing temporary (i.e., not permanent).
- Excavation and transfer to landfill assumed to be done by hydraulic excavator.
- Number of crew days for work is assumed to be approximately equal to the total hours of equipment operation calculated by SiteWise divided by 8 hours per day (SiteWise calculates 30 days) multiplied by "factors" to account for items which will lengthen the time. These factors include:
  - Depth to 100 ft – multiply by 2 (30 days * 2 = 60 days)
  - Address sheet piling – multiply by 3 (60 days * 3 = 180 days)
- Crew is assumed to be 2 individuals.
- Equipment – assume one trip to site for one excavator
- Oversight consultant (1 individual riding in a light duty truck)
  - Daily trips (180 trips), 40 miles round-trip
- Disposal of excavated materials
  - Remove drainage layer, replace liner and drainage layer over 2 acres
  - Transfer and place 7,111 cubic yards of material into new cell

Alternative 4 – PRB Installation and Disposal of Excavated Material

<u>SiteWise Input – Input into "Remedial Action Construction" tab in SiteWise "Alternative 4"</u>

- Material Production
  - Well Materials
  - Treatment Chemicals & Materials
    - Treatment 1 – ZVI for PRB. 6,000 tons*2,000=12,000,000 lbs
  - GAC
  - Construction Materials
    - Landfill liner and drainage layer not included (negligible amount of material)
    - Material 1 – Gravel used to represent sand for PRB. 4,667 tons * 2,000 lbs per ton / 3,000 lbs per yd^3 * 27 ft^3 per yd^3 = 84,006 ft^3
  - Well Decommissioning

- Transportation
  - Personnel Transportation – Road
    - All personnel assumed to be local (~20 miles one way, 40 miles round trip)
    - Trip 1 – Round-trips for 2 person crew for excavation and transfer to landfill. Number of trips calculated by taking total number of equipment operation hours from SiteWise Remedial Action Construction output file, Equipment Use – Earthwork sheet (138.9+103.8=242.7) and dividing by 8 hours per day and rounding result as appropriate (242.7/8=~30 days). As described above, multiply by factor of 2 due to depth = 100 ft, and then by factor of three to account for sheet piling work. Result is estimate of 180 days.
    - Trip 2 – Round-trips for consultant on a daily basis for 180 days.
    - Trip 3 – 1 Excavator, assuming only 1 round trip to site. Select "heavy duty" for vehicle type and diesel for fuel used.
  - Personnel Transportation – Air
  - Personnel Transportation – Rail
  - Equipment Transportation – Road
    - Trip 1 – Sheet piling and bracing (steel)
      - Assume excavations done in 100 by 20 ft sections, 2 sheet piles (one for each side of trench), 35 lbs/sq. ft, and divide by 2000 to convert lbs to tons (100*20*2*35/2000=70 tons). Average weight per round trip (with empty return trip) is 70/2=35 tons. Since weight carried for an on-road truck cannot exceed 40 lbs, assume 2 round trips with an average of 17.5 lbs (35/2).
      - Sheet piling assumed to be shipped from Boston, MA (~45 miles one way, 90 miles round trip). Multiply the mileage by 2 for 2 round trips (90*2=180).
  - Equipment Transportation – Air
  - Equipment Transportation – Rail
  - Equipment Transportation – Water

- Equipment Use – Equipment use is a hydraulic excavator for excavation and transfer of excavated material to landfill. SiteWise determines the equipment horsepower and bucket size based on total cubic yards excavated. Although this may be appropriate for single, large excavation, it is not necessarily appropriate for trenching. In addition, the productivity rates provided in SiteWise for excavator use do not agree with those provided by RS Means construction data. The Look Up Table in SiteWise Input Sheet.xls was modified to provide a consistent and appropriate equipment size for all trenching. Productivity rates were also updated to be consistent with RS Means construction data.

- Earthwork
  - Equipment 1 – Excavator for 256,800 ft^3 excavation volume. Divide by 27 to convert from cubic feet to cubic yards (256,800/27 = 9511 yd^3)
  - Equipment 2 – Excavator for transfer of 7,111 cubic yards of material into new landfill cell.
- Drilling
- Pump operation
- Diesel and Gasoline Pumps
- Blower, Compressor, Mixer, and Other Equipment
- Generators
- Agricultural Equipment
- Capping Equipment
- Mixing Equipment

- Residual Handling
  - Residue Disposal/Recycling
  - Landfill Operations
  - Thermal/Catalytic Oxidizers
  - Water Consumption
  - Landfill Methane Emissions

- Other Known On-Site Activities

Alternative 4 – System O&M

Scope of Work (some details not outlined in the FFS are assumed)

- Annual O&M – The specific materials, equipment, and labor hours required for this minor O&M ($15,000 per year) are unknown. Therefore, detailed footprinting using SiteWise was not done for this component of this remedial alternative.
- Wall redevelopment every 5 year
  - The specific materials, equipment, and labor hours required are unknown. Therefore, detailed footprinting using SiteWise was not done for this component of this remedial alternative.
  - Based on *U.S. Carbon Dioxide Emissions and Intensities Over Time: A Detailed Accounting of Industries, Government and Households* (April 2010), approximately 1 lb of CO_2 is emitted per dollar of United States GDP. In the absence of other information, it is assumed that the specified activity also has an emission profile of approximately 1 lb of CO_2 emitted per dollar of cost. This emission is likely based on a mix of fuel uses and activities.
  - The non-discounted cost for the wall redevelopment every 5 years over the course of 100 years of remedy operation (20 redevelopment events total) is estimated at $40,000 each, for a total cost of $800,000. This would lead to the emission of approximately 800,000 lbs of CO_2, or 363 metric tons of CO_2. (800,000/2204.6=363)

Alternative 4 – System O&M

<u>SiteWise Input – Input into "Remedial Action Operations" tab in SiteWise "Alternative 4"</u>

- Material Production
    - Well Materials
    - Treatment Chemicals & Materials
    - GAC
    - Construction Materials
    - Well Decommissioning

- Transportation
    - Personnel Transportation – Road
    - Personnel Transportation – Air
    - Personnel Transportation – Rail
    - Equipment Transportation – Road
    - Equipment Transportation – Air
    - Equipment Transportation – Rail
    - Equipment Transportation – Water

- Equipment Use
    - Earthwork
    - Drilling
    - Pump operation
    - Diesel and Gasoline Pumps
    - Blower, Compressor, Mixer, and Other Equipment
    - Generators
    - Agricultural Equipment
    - Capping Equipment
    - Mixing Equipment

- Residual Handling
    - Residue Disposal/Recycling
    - Landfill Operations
    - Thermal/Catalytic Oxidizers
    - Water Consumption
    - Landfill Methane Emissions

- Other Known On-Site Activities
    - CO2 Emissions – The non-discounted cost for the wall redevelopment every 5 years over the course of 100 years of remedy operation (20 redevelopment events total) is estimated at $40,000 each, for a total cost of $800,000. This would lead to the emission of approximately 800,000 lbs of CO2, or 363 metric tons of CO2. (800000/2204.6=363)

Alternative 4 – LTM

Scope of Work (some details not outlined in the FFS are assumed)

- Groundwater monitoring
    - Water levels at 67 monitoring wells 2 times per year
    - Water quality sampling at 38 wells in the fall and 16 wells in the spring
    - Low-flow sampling
    - Analytical parameters: field parameters, selected inorganic parameters, metals
    - Reduction in cost after 10 years from $100,000 to $75,000 listed in Table C-4 of December 2010 Draft FFS. Since no reason for the decrease in cost is listed, it is assumed to be due to analyzing for fewer parameters and not a reduction in the number of wells sampled.

Alternative 4 – LTM

<u>SiteWise Input – Input into "Longterm Monitoring" tab in SiteWise "Alternative 4"</u>

- Material Production
    - Well Materials
    - Treatment Chemicals & Materials
    - GAC
    - Construction Materials
    - Well Decommissioning

- Transportation
    - Personnel Transportation – Road
        - Trip 1 – water levels (assume 3 people, 1 day, 2 times per year)
        - Trip 2 – sampling (assume 2 people, 6 days in fall and 2 people, 3 days in spring)
    - Personnel Transportation – Air
    - Personnel Transportation – Rail
    - Equipment Transportation – Road
    - Equipment Transportation – Air
    - Equipment Transportation – Rail
    - Equipment Transportation – Water

- Equipment Use
    - Earthwork
    - Drilling
    - Pump operation
    - Diesel and Gasoline Pumps
    - Blower, Compressor, Mixer, and Other Equipment
    - Generators
    - Agricultural Equipment
    - Capping Equipment
    - Mixing Equipment

- Residual Handling
    - Residue Disposal/Recycling
    - Landfill Operations
    - Thermal/Catalytic Oxidizers
    - Water Consumption
    - Landfill Methane Emissions

- Other Known On-Site Activities

Other Supporting Calculations
Shepley's Hill Landfill Pilot GSR Evaluation
Alternative 4 – PRB

% of Total Energy Usage from Renewable Resources

- This alternative does not rely on electricity, and no renewable energy is assumed for any of the other energy demands. Thus, none from renewable resources.

Hazardous Air Pollutants

- None for this alternative.

Refined Materials Use

Assumptions:

- 6,000 tons of iron = 12,000,000 pounds
- 100% virgin material, 0% recycled material

Unrefined Materials Use

- 4,667 tons of sand (from SiteWise)

Tons of Non-Hazardous Waste

- None (all excavated material disposed on site).

Risks to On-Site Workers and from Transportation

- Refer to "Total" tab of the "Summary.xlsx" spreadsheet.
- For transportation related risks, sum injuries and fatalities for all transportation activities
- Add total risk form transportation and non-transportation, and then subtract the transportation sums previously calculated, to get non-transportation.
- For non-transportation risk, need to account for extra hours that were added to account for sheet pile work and depth of excavation. Since SiteWise calculated 30 days of excavation, and we added 150 days, we need to take the SiteWise risks for that task in equipment use and add an additional 5 times that amount to the non-transportation risk.
- For this alternative, the safety risk is higher for equipment use associated with wall construction (0.38) than for transportation (0.07).

Heavy Truck Trips through Residential Areas

- Project team indicated that trucks could enter through a non-residential route.

Table C-4
Alternative 4 - Permeable Reactive Barrier

Item	Quantity	Units	Unit Cost	Cost per Event/Year	Non-Discounted Cost	Discounted Cost
Study/Design/Capital Costs						
Design						
Engineering & Oversight	1	job	15%	$1,500,000	$1,500,000	$1,500,000
Installation						
Installation 400' long x 6' wide barrier *-includes driving of sheet piles, bracing, excavation, placement of iron, removal of sheetpiles*	42,800	sq. ft.	$150 / sq. ft.	$6,420,000	$6,420,000	$6,420,000
Iron Costs	6,000	tons	$750 / ton	$4,500,000	$4,500,000	$4,500,000
Sand Costs	4,667	tons	$13 / ton	$60,671	$60,671	$60,671
Excavated Material Disposal Under Cap						
Remove Drainage Layer, Replace Liner & Drainage Layer	2	acres	$95,000 / acre	$190,000	$190,000	$190,000
Transfer & Place Material into New Cell	7,111	cub. yd.	$15 / cub. yd.	$106,665	$106,665	$106,665
Contingency	1	job	15%	$15	$15	$15
Total Capital Costs					**$12,777,351**	**$12,777,351**

O & M Costs	Quantity	Units	Unit Cost	Cost per Event/Year	Non-Discounted Cost	Discounted Cost
Cap/Groundwater/LUC Monitoring						
Annual Monitoring (years 1-10)	10	years	$100,000 / yr	$100,000	$1,000,000	$866,230
Annual Monitoring (years 11-100)	90	years	$75,000 / yr	$75,000	$6,750,000	$1,934,617
PRB						
Annual O+M	100	years	$15,000 / yr	$15,000	$1,500,000	$516,858
Wall Redevelopment every 5 years	20	events	$40,000 / event	$40,000	$800,000	$261,900
Total O&M and Monitoring Costs					**$10,050,000**	**$3,579,606**
TOTAL					**$22,827,351**	**$16,356,957**

Discount Rate for Present Value Calculations **2.7%**

Note:

Discount Rate is 30-Year Real Interest Rate from OMB Circular No. A-94 – Appendix C.

Project: GSR Pilot for Shepley's Hill Landfill
Option or Alternative: Alternative 4: PRB
Current Date: 3/4/2011

year	up-front cost	annual cost	present value of cost each year	cumulative cash flow	
		(no discounting)	2.7%	no discounting	2.7%
0	$12,777,351	$0	$12,777,351	$12,777,351	$12,777,351
1	$0	$115,000	$111,977	$12,892,351	$12,889,328
2	$0	$115,000	$109,033	$13,007,351	$12,998,360
3	$0	$115,000	$106,166	$13,122,351	$13,104,527
4	$0	$115,000	$103,375	$13,237,351	$13,207,902
5	$0	$155,000	$135,669	$13,392,351	$13,343,570
6	$0	$115,000	$98,011	$13,507,351	$13,441,581
7	$0	$115,000	$95,434	$13,622,351	$13,537,016
8	$0	$115,000	$92,925	$13,737,351	$13,629,941
9	$0	$115,000	$90,482	$13,852,351	$13,720,424
10	$0	$155,000	$118,748	$14,007,351	$13,839,172
11	$0	$90,000	$67,138	$14,097,351	$13,906,310
12	$0	$90,000	$65,373	$14,187,351	$13,971,683
13	$0	$90,000	$63,654	$14,277,351	$14,035,337
14	$0	$90,000	$61,981	$14,367,351	$14,097,317
15	$0	$130,000	$87,174	$14,497,351	$14,184,491
16	$0	$90,000	$58,765	$14,587,351	$14,243,256
17	$0	$90,000	$57,220	$14,677,351	$14,300,475
18	$0	$90,000	$55,715	$14,767,351	$14,356,191
19	$0	$90,000	$54,251	$14,857,351	$14,410,441
20	$0	$130,000	$76,302	$14,987,351	$14,486,743
21	$0	$90,000	$51,436	$15,077,351	$14,538,179
22	$0	$90,000	$50,083	$15,167,351	$14,588,262
23	$0	$90,000	$48,767	$15,257,351	$14,637,028
24	$0	$90,000	$47,484	$15,347,351	$14,684,513
25	$0	$130,000	$66,786	$15,477,351	$14,751,298
26	$0	$90,000	$45,021	$15,567,351	$14,796,319
27	$0	$90,000	$43,837	$15,657,351	$14,840,156
28	$0	$90,000	$42,684	$15,747,351	$14,882,840
29	$0	$90,000	$41,562	$15,837,351	$14,924,403
30	$0	$130,000	$58,456	$15,967,351	$14,982,859
31	$0	$90,000	$39,406	$16,057,351	$15,022,265
32	$0	$90,000	$38,370	$16,147,351	$15,060,634
33	$0	$90,000	$37,361	$16,237,351	$15,097,995
34	$0	$90,000	$36,379	$16,327,351	$15,134,374
35	$0	$130,000	$51,166	$16,457,351	$15,185,540
36	$0	$90,000	$34,491	$16,547,351	$15,220,031
37	$0	$90,000	$33,584	$16,637,351	$15,253,615
38	$0	$90,000	$32,701	$16,727,351	$15,286,316
39	$0	$90,000	$31,842	$16,817,351	$15,318,158
40	$0	$130,000	$44,784	$16,947,351	$15,362,942

Project: GSR Pilot for Shepley's Hill Landfill
Option or Alternative: Alternative 4: PRB
Current Date: 3/4/2011

year	up-front cost	annual cost	present value of cost each year	cumulative cash flow	
		(no discounting)	2.7%	no discounting	2.7%
41	$0	$90,000	$30,189	$17,037,351	$15,393,132
42	$0	$90,000	$29,396	$17,127,351	$15,422,527
43	$0	$90,000	$28,623	$17,217,351	$15,451,150
44	$0	$90,000	$27,870	$17,307,351	$15,479,020
45	$0	$130,000	$39,199	$17,437,351	$15,518,219
46	$0	$90,000	$26,424	$17,527,351	$15,544,644
47	$0	$90,000	$25,730	$17,617,351	$15,570,373
48	$0	$90,000	$25,053	$17,707,351	$15,595,426
49	$0	$90,000	$24,394	$17,797,351	$15,619,821
50	$0	$130,000	$34,310	$17,927,351	$15,654,131
51	$0	$90,000	$23,129	$18,017,351	$15,677,259
52	$0	$90,000	$22,521	$18,107,351	$15,699,780
53	$0	$90,000	$21,929	$18,197,351	$15,721,708
54	$0	$90,000	$21,352	$18,287,351	$15,743,060
55	$0	$130,000	$30,031	$18,417,351	$15,773,091
56	$0	$90,000	$20,244	$18,507,351	$15,793,335
57	$0	$90,000	$19,712	$18,597,351	$15,813,047
58	$0	$90,000	$19,194	$18,687,351	$15,832,241
59	$0	$90,000	$18,689	$18,777,351	$15,850,930
60	$0	$130,000	$26,286	$18,907,351	$15,877,215
61	$0	$90,000	$17,719	$18,997,351	$15,894,935
62	$0	$90,000	$17,253	$19,087,351	$15,912,188
63	$0	$90,000	$16,800	$19,177,351	$15,928,988
64	$0	$90,000	$16,358	$19,267,351	$15,945,346
65	$0	$130,000	$23,007	$19,397,351	$15,968,353
66	$0	$90,000	$15,509	$19,487,351	$15,983,863
67	$0	$90,000	$15,102	$19,577,351	$15,998,964
68	$0	$90,000	$14,705	$19,667,351	$16,013,669
69	$0	$90,000	$14,318	$19,757,351	$16,027,987
70	$0	$130,000	$20,138	$19,887,351	$16,048,125
71	$0	$90,000	$13,575	$19,977,351	$16,061,700
72	$0	$90,000	$13,218	$20,067,351	$16,074,918
73	$0	$90,000	$12,871	$20,157,351	$16,087,788
74	$0	$90,000	$12,532	$20,247,351	$16,100,321
75	$0	$130,000	$17,626	$20,377,351	$16,117,947
76	$0	$90,000	$11,882	$20,467,351	$16,129,829
77	$0	$90,000	$11,570	$20,557,351	$16,141,398
78	$0	$90,000	$11,265	$20,647,351	$16,152,664
79	$0	$90,000	$10,969	$20,737,351	$16,163,633
80	$0	$130,000	$15,428	$20,867,351	$16,179,061
81	$0	$90,000	$10,400	$20,957,351	$16,189,461

Project: GSR Pilot for Shepley's Hill Landfill
Option or Alternative: Alternative 4: PRB
Current Date: 3/4/2011

year	up-front cost	annual cost		present value of cost each year		cumulative cash flow	
		(no discounting)		2.7%		no discounting	2.7%
82	$0	$90,000		$10,127		$21,047,351	$16,199,588
83	$0	$90,000		$9,860		$21,137,351	$16,209,448
84	$0	$90,000		$9,601		$21,227,351	$16,219,049
85	$0	$130,000		$13,504		$21,357,351	$16,232,553
86	$0	$90,000		$9,103		$21,447,351	$16,241,656
87	$0	$90,000		$8,864		$21,537,351	$16,250,520
88	$0	$90,000		$8,631		$21,627,351	$16,259,151
89	$0	$90,000		$8,404		$21,717,351	$16,267,554
90	$0	$130,000		$11,820		$21,847,351	$16,279,374
91	$0	$90,000		$7,968		$21,937,351	$16,287,342
92	$0	$90,000		$7,758		$22,027,351	$16,295,100
93	$0	$90,000		$7,554		$22,117,351	$16,302,654
94	$0	$90,000		$7,356		$22,207,351	$16,310,010
95	$0	$130,000		$10,345		$22,337,351	$16,320,355
96	$0	$90,000		$6,974		$22,427,351	$16,327,329
97	$0	$90,000		$6,791		$22,517,351	$16,334,120
98	$0	$90,000		$6,612		$22,607,351	$16,340,732
99	$0	$90,000		$6,438		$22,697,351	$16,347,170
100	$0	$130,000		$9,055		$22,827,351	$16,356,225

Net Present Value (NPV)-> $16,356,225

*positive dollar value is a "cost", negative dollar value is a "savings"

GSR Team Calculations to Split Energy Results from SiteWise into "Direct" and "Indirect"
Alternative 4 - PRB

	Reported by SiteWise		Assigned by GSR Team from SiteWise Output			Added by GSR Team	Total Calculated by GSR Team
			Scope 1 (direct)	Scope 2 (indirect)	Scope 3 (indirect)	Scope 3 (indirect)	
phase	activity	energy used (MMBTU)	energy used (MMBTU)	energy used (MMBTU)	energy used (MMBTU)	energy used (MMBTU)	
PRB Installation and Disposal of Excavated Material (Remedial Action Construction tab)	Consumables	47814.56	0.00	0.00	47814.56	0.00	47814.56
	Transportation-Personnel	119.74	0.00	0.00	119.74	28.74	148.47
	Transportation-Equipment	4.12	0.00	0.00	4.12	0.99	5.11
	Equipment Use and Misc	475.76	475.76	0.00	0.00	114.18	589.94
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-total	48414.17	475.76	0.00	47938.41	143.91	48558.08
System (Remedial Action Operations tab)	Consumables	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Equipment	0.00	0.00	0.00	0.00	0.00	0.00
	Equipment Use and Misc	0.00	0.00	0.00	0.00	0.00	0.00
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-total	0.00	0.00	0.00	0.00	0.00	0.00
LTM (Longterm Monitoring tab)	Consumables	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	363.73	0.00	0.00	363.73	87.30	451.03
	Transportation-Equipment	0.00	0.00	0.00	0.00	0.00	0.00
	Equipment Use and Misc	0.00	0.00	0.00	0.00	0.00	0.00
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-total	363.73	0.00	0.00	363.73	87.30	451.03
total		48777.91	475.76	0.00	48302.15	231.20	49009.11

Note: For energy use related to fuel use for transportation or on-site equipment use, SiteWise reports energy use associated with combustion only. The added Scope 3 energy use for these activities take into account upstream energy use (i.e. energy required for extraction, refining, etc.). The added energy is based on multipliers used in the GREET software, version 1.8d.1, which in this case equates to multiplying energy used in fuel combustion by 0.24 to calculate the upstream energy use.

Electricity use reported by SiteWise in units of kWh is "Direct Scope 1", meaning it is energy consumed at the location of the project. However, energy use associated with electricity reported by SiteWise in units of MMBtu is a life-cycle value which also includes a factor to account for energy used elsewhere required to generate the electricity ("Indirect Scope 2"). Here, 33% of the life-cycle value reported by SiteWise is considered to be "Scope 1" on-site energy use, and 67% is considered to be "Scope 2" energy used in electricity generation.

GSR Team Calculations to Split GHG Results from SiteWise into "Direct" and "Indirect"
Alternative 4 - PRB

phase	Reported by SiteWise		Assigned by GSR Team from SiteWise Output			Added by GSR Team	Total Calculated by GSR Team
			Scope 1 (direct)	Scope 2 (indirect)	Scope 3 (indirect)	Scope 3 (indirect)	
	activity	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	
PRB Installation and Disposal of Excavated Material (Remedial Action Construction tab)	Consumables	6871.14	0.00	0.00	6871.14	0.00	6871.14
	Transportation-Personnel	10.93	0.00	0.00	10.93	2.62	13.55
	Transportation-Equipment	0.28	0.00	0.00	0.28	0.07	0.35
	Equipment Use and Misc	29.08	29.08	0.00	0.00	6.98	36.06
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-total	6911.44	29.08	0.00	6882.36	9.67	6921.11
System (Remedial Action Operations tab)	Consumables	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Equipment	0.00	0.00	0.00	0.00	0.00	0.00
	Equipment Use and Misc	362.88	0.00	0.00	362.88	0.00	362.88
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-total	362.88	0.00	0.00	362.88	0.00	362.88
LTM (Longterm Monitoring tab)	Consumables	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	33.26	0.00	0.00	33.26	7.98	41.24
	Transportation-Equipment	0.00	0.00	0.00	0.00	0.00	0.00
	Equipment Use and Misc	0.00	0.00	0.00	0.00	0.00	0.00
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-total	33.26	0.00	0.00	33.26	7.98	41.24
total		7307.57	29.08	0.00	7278.49	17.65	7325.22

Note: For GHG emissions related to fuel use for transportation or on-site equipment use, SiteWise reports emissions associated with combustion only. The added Scope 3 emissions for these activities take into account upstream emissions (i.e. emissions related to extraction, refining, etc.). The added emissions factor is based on multipliers used in the GREET software, version 1.8d.1, which in this case equates to multiplying emission from fuel combustion by 0.24 to calculate the upstream emissions.

CO2e reported by SiteWise for electricity use is all associated with generation of the electricity ("Indirect Scope 2").

APPENDIX C-4

Alternative A – Barrier Wall/PRB (Red Cove)

Appendix C4
Assumptions for SiteWise Input and Other Calculations
Shepley's Hill Pilot GSR Evaluation
Alternative A – Barrier Wall/PRB

Alternative A – Barrier Wall/PRB – SiteWise "Alternative 5" Directory

- Installation of an 850'*30" soil-bentonite slurry wall and 200'*30" PRB
- Disposal of excavated material under the landfill cap
- Wall redevelopment every 5 years
- One time PRB replacement
- 100 years of operation

The notes pertaining to SiteWise input are organized by the following sections of SiteWise input:

- Wall Installation and Disposal of Excavated Material – Uses "Remedial Action Construction" tab of SiteWise input for SiteWise "Alternative 5"

- System O&M – Uses "Remedial Action Operations" tab of SiteWise input for SiteWise "Alternative 5"

For each section of SiteWise, all the sections are listed, with pertinent information added only for those sections of the input sheet where data were added.

Other calculations done outside of SiteWise are then presented. These include the following:

- % of total energy from renewable resources
- Hazardous Air Pollutants
- Refined Material Use
- Unrefined Material Use
- Tons of non-hazardous waste
- Risks to on-site works and from transportation
- Heavy truck trips through residential areas

Additional tables are attached which show how SiteWise outputs were split into "direct" and "indirect" energy use and greenhouse gas emissions. For definitions of direct and indirect energy use and emissions, please refer to section 2.2.2 of the evaluation report.

A cost sheet is also attached. Some of the information on the cost sheet comes from Appendix C of the December 2010 Draft FFS (also attached). Information regarding the cost calculations is as follows:

- The capital cost of $2,354,264 is taken from Table C-A of the December 2010 Draft FFS. The costs mainly consist of engineering and oversight for system design, installation of the slurry wall and PRB, materials for the slurry wall and PRB, and disposal of excavated materials under the landfill cap.

- The annual cost of $15,000 per year is taken from Table C-A of the December 2010 Draft FFS. Table C-A also includes a one time PRB replacement for $1,000,000 and wall redevelopment every 5 years during a 100 year period priced at $25,000 per event.

- Capital costs are assumed to occur in year 0, and annual costs are assumed to occur in years 1 to 100.

- To determine net present value (NPV), a 2.7 percent discount rate is applied to future costs, which is consistent with the discount rate applied in the December 2010 Draft FFS.

- NPV is calculated by discounting future costs to present-day dollars using the following equation:

$$PV = \frac{FV}{(1+i)^n} = C \times FV$$

PV is the present value
FV is the value in year "n" (i.e., future value)
i is the discount rate
C is the discount factor, which equals $1/(1+i)^n$

Alternative A – Wall Installation and Disposal of Excavated Material

<u>*Scope of Work (some details not outlined in the FFS are assumed)*</u>

- Barrier Wall Installation
    - Table C-A says soil-bentonite slurry wall will be 42,500 ft^2 (length*depth) and 30 inches (2.5 ft) wide, so excavation volume is 106,250 ft^3
- PRB installation
    - Table C-A says PRB will be 10,000 ft^2 (length*depth) and 2.5 ft wide, so excavation volume is 25,000 ft^3
    - 833 tons of iron and 648 tons of sand
- Installation will require sheet pile steel, assume sheet piling and bracing temporary (i.e., not permanent).
- Excavation and transfer to landfill assumed to be done by hydraulic excavator.
- Number of crew days for work is assumed to be approximately equal to the total hours of equipment operation calculated by SiteWise divided by 8 hours per day (SiteWise calculates 13 days) multiplied by "factors" to account for items which will lengthen the time. These factors include:
    - Depth to 50 ft – no factor needed for depth as I n Alternative 4
    - Address sheet piling – multiply by 2 rather than 3 in alternative 4 since depth is less (13 days * 2 = 26 days)
- Crew is assumed to be 2 individuals.
- Equipment – assume one trip to site for one excavator
- Oversight consultant (1 individual riding in a light duty truck)
    - Daily trips (26 days), 40 miles round-trip
- Disposal of excavated materials
    - Remove drainage layer, replace liner and drainage layer over 0.6 acres
    - Transfer and place 2,106 cubic yards of material into new cell

Alternative A – Wall Installation and Disposal of Excavated Material

SiteWise Input – Input into "Remedial Action Construction" tab in SiteWise "Alternative 5"

- Material Production
  - Well Materials
  - Treatment Chemicals & Materials
    - Treatment 1 – ZVI for PRB. 833 tons*2,000=1,666,000 lbs
  - GAC
  - Construction Materials
    - Landfill liner and drainage layer not included (negligible amount of material)
    - Material 1 – Gravel used to represent soil-bentonite slurry mix for barrier wall. 42,500 ft^2 area by 2.5 ft thick
    - Material 2 – Gravel used to represent sand for PRB. 648 tons * 2,000 lbs per ton / 3,000 lbs per yd^3 * 27 ft^3 per yd^3 = 11,664 ft^3
  - Well Decommissioning

- Transportation
  - Personnel Transportation – Road
    - Assume all are local (~40 miles round trip)
    - Trip 1 – Round-trips for 2 person crew for excavation and transfer to landfill. Number of trips calculated by taking total number of equipment operation hours from SiteWise Remedial Action Construction output file, Equipment Use – Earthwork sheet (71+30.8=101.8) and dividing by 8 hours per day and rounding result as appropriate (~13 days). As described above, multiply by factor of 2 to account for sheet piling work. Result is estimate of 26 days.
    - Trip 2 – Round-trips for consultant on a daily basis for 26 days.
    - Trip 3 – 1 Excavator, assume 1 round trip to site. Select "heavy duty" for vehicle type and diesel for fuel used.
  - Personnel Transportation – Air
  - Personnel Transportation – Rail
  - Equipment Transportation – Road
    - Trip 1 – Sheet piling and bracing (steel)
      - Assume excavations done in 100 by 20 ft sections, 2 sheet piles (one for each side of trench), 35 lbs/sq. ft, and divide by 2000 to convert lbs to tons (100*20*2*35/2000=70 tons). Average weight per round trip (with empty return trip) is 70/2=35 tons. Since weight carried for an on-road truck cannot exceed 40 lbs, assume 2 round trips with an average of 17.5 lbs (35/2).
      - Sheet piling assumed to be shipped from Boston, MA (~45 miles one way, 90 miles round trip). Multiply the mileage by 2 for 2 round trips (90*2=180).
  - Equipment Transportation – Air
  - Equipment Transportation – Rail
  - Equipment Transportation – Water

- Equipment Use – Equipment use is a hydraulic excavator for excavation and transfer of excavated material to landfill. SiteWise determines the equipment horsepower and bucket size based on total cubic yards excavated. Although this may be appropriate for single, large excavation, it is not necessarily appropriate for trenching. In addition, the productivity rates provided in SiteWise for excavator use do not agree with those provided by RS Means construction data. The Look Up Table in SiteWise Input Sheet.xls was modified to provide a consistent and appropriate equipment size for all trenching. Productivity rates were also updated to be consistent with RS Means construction data.

- Earthwork
  - Equipment 1 – Excavator for 106,250 ft^3 (850*2.5*50) excavation volume for soil-bentonite slurry wall and 25,000 ft^3 for PRB section (200*2.5*50), for a total of 131,250 ft^3 excavation volume. Divide by 27 to convert from cubic feet to cubic yards (131,250/27 = 4861 yd^3)
  - Equipment 2 – Excavator for transfer of 2,106 cubic yards of material into new landfill cell.
- Drilling
- Pump operation
- Diesel and Gasoline Pumps
- Blower, Compressor, Mixer, and Other Equipment
- Generators
- Agricultural Equipment
- Capping Equipment
- Mixing Equipment

- Residual Handling
  - Residue Disposal/Recycling
  - Landfill Operations
  - Thermal/Catalytic Oxidizers
  - Water Consumption
  - Landfill Methane Emissions

- Other Known On-Site Activities

Alternative A – System O&M

Scope of Work (some details not outlined in the FFS are assumed)

- Annual O&M – The specific materials, equipment, and labor hours required for this minor O&M ($15,000 per year) are unknown. Therefore, detailed footprinting using SiteWise was not done for this component of this remedial alternative.
- Wall redevelopment every 5 year and one time PRB replacement
    - The specific materials, equipment, and labor hours required are unknown. Therefore, detailed footprinting using SiteWise was not done for this component of this remedial alternative.
    - Based on *U.S. Carbon Dioxide Emissions and Intensities Over Time: A Detailed Accounting of Industries, Government and Households* (April 2010), approximately 1 lb of CO2 is emitted per dollar of United States GDP. In the absence of other information, it is assumed that the specified activity also has an emission profile of approximately 1 lb of CO2 emitted per dollar of cost. This emission is likely based on a mix of fuel uses and activities.
    - The non-discounted cost for the wall redevelopment every 5 years over the course of 100 years of remedy operation (20 redevelopment events total) is estimated at $25,000 each. In addition, the non-discounted cost for the one-time PRB replacement is estimated at $1,000,000, for a combined total cost of $1,500,000. This would lead to the emission of approximately 1,500,000 lbs of CO2, or 680 metric tons of CO2. (1,500,000/2204.6).

Alternative A – System O&M

SiteWise Input – Input into "Remedial Action Operations" tab in SiteWise "Alternative 5"

- Material Production
  - Well Materials
  - Treatment Chemicals & Materials
  - GAC
  - Construction Materials
  - Well Decommissioning

- Transportation
  - Personnel Transportation – Road
  - Personnel Transportation – Air
  - Personnel Transportation – Rail
  - Equipment Transportation – Road
  - Equipment Transportation – Air
  - Equipment Transportation – Rail
  - Equipment Transportation – Water

- Equipment Use
  - Earthwork
  - Drilling
  - Pump operation
  - Diesel and Gasoline Pumps
  - Blower, Compressor, Mixer, and Other Equipment
  - Generators
  - Agricultural Equipment
  - Capping Equipment
  - Mixing Equipment

- Residual Handling
  - Residue Disposal/Recycling
  - Landfill Operations
  - Thermal/Catalytic Oxidizers
  - Water Consumption
  - Landfill Methane Emissions

- Other Known On-Site Activities
  - CO_2 Emissions – The non-discounted cost for the wall redevelopment every 5 years over the course of 100 years of remedy operation (20 redevelopment events total) is estimated at $25,000 each. In addition, the non-discounted cost for the one time PRB replacement is estimated at $1,000,000, for a combined total cost of $1,500,000. This would lead to the emission of approximately 1,500,000 lbs of CO_2, or 675 metric tons of CO_2. (1,500,000*0.00045=675)

Other Supporting Calculations
Shepley's Hill Landfill Pilot GSR Evaluation
Alternative A – Barrier Wall/PRB

% of Total Energy Usage from Renewable Resources

- This alternative does not rely on electricity, and no renewable energy is assumed for any of the other energy demands. Thus, none from renewable resources.

Hazardous Air Pollutants

- None for this alternative.

Refined Materials Use

Assumptions:

- 833 tons of iron = 1,666,000 pounds
- 100% virgin material, 0% recycled material

Unrefined Materials Use

- 850*2.5*50 = 106,250 ft^3 of soil and bentonite = 11,805,556 pounds/2000 = 5903 tons
- 648 tons of sand

Tons of Non-Hazardous Waste

- None (all excavated material disposed on site).

Risks to On-Site Workers and from Transportation

- Refer to "Total" tab of the "Summary.xlsx" spreadsheet.
- For transportation related risks, sum injuries and fatalities for all transportation activities
- Add total risk form transportation and non-transportation, and then subtract the transportation sums previously calculated, to get non-transportation.
- For non-transportation risk, need to account for extra hours that were added to account for sheet pile work and depth of excavation. Since SiteWise calculated 13 days of excavation, and we added 13 days, we need to take the SiteWise risks for that task in equipment use and add an additional 1 times that amount to the non-transportation risk.
- For this alternative, the safety risk is higher for equipment use associated with wall construction (0.005) than for transportation (0.002).

Heavy Truck Trips through Residential Areas

- Project team indicated that trucks could enter through a non-residential route.

Table C-A
Alternative A - Containment Wall/Permeable Reactive Barrier

Item	Quantity	Units	Unit Cost	Cost per Event/Year	Non-Discounted Cost	Discounted Cost
Study/Design/Capital Costs						
Design						
Engineering & Oversight	1	job	30%	$470,000	$470,000	$470,000
Installation						
Installation of 850 ft x 30" Soil-Bentonite Slurry Wall	42,500	sq. ft.	$15 / sq. ft.	$637,500	$637,500	$637,500
- Cost includes excavation, slurry mix prep and placement						
Installation of Wall 200 ft x 30" wide PRB	10,000	sq. ft.	$20 / sq. ft.	$200,000	$200,000	$200,000
- Cost includes biopolymer wall and placement of iron						
Iron Costs	833	tons	$750 / ton	$624,750	$624,750	$624,750
Sand Costs	648	tons	$13 / ton	$8,424	$8,424	$8,424
Excavated Material Disposal Under Cap						
Remove Drainage Layer, Replace Liner & Drainage Layer	0.6	acres	$95,000 / acre	$57,000	$57,000	$57,000
Transfer & Place Material into New Cell	2,106	cub. yd.	$15 / cub. yd.	$31,590	$31,590	$31,590
Contingency	1	job	20%	$325,000	$325,000	$325,000
Total Capital Costs					**$2,354,264**	**$2,354,264**

O & M Costs	Quantity	Units	Unit Cost	Cost per Event/Year	Non-Discounted Cost	Discounted Cost
Slurry Wall/PRB						
Annual O+M	100	years	$15,000 / yr	$15,000	$1,500,000	$516,858
Wall Redevelopment every 5 years	20	events	$25,000 / event	$25,000	$500,000	$163,687
One Time PRB Replacement	1	ea	$1,000,000 / ea	$1,000,000	$1,000,000	$263,923
Total O&M and Monitoring Costs					**$3,000,000**	**$944,469**
TOTAL					**$5,354,264**	**$3,298,733**

Discount Rate for Present Value Calculations **2.7%**

Note:

Discount Rate is 30-Year Real Interest Rate from OMB Circular No. A-94 – Appendix C.
Assumes PRB Replacement at 50 years.
Groundwater monitoring included in Alternatives 1-5.

Project: GSR Pilot for Shepley's Hill Landfill
Option or Alternative: Alternative A: Barrier Wall/PRB (Red Cove)
Current Date: 3/4/2011

year	up-front cost	annual cost	present value of cost each year	cumulative cash flow	
		(no discounting)	2.7%	no discounting	2.7%
0	$2,354,264	$0	$2,354,264	$2,354,264	$2,354,264
1	$0	$15,000	$14,606	$2,369,264	$2,368,870
2	$0	$15,000	$14,222	$2,384,264	$2,383,091
3	$0	$15,000	$13,848	$2,399,264	$2,396,939
4	$0	$15,000	$13,484	$2,414,264	$2,410,423
5	$0	$40,000	$35,011	$2,454,264	$2,445,434
6	$0	$15,000	$12,784	$2,469,264	$2,458,218
7	$0	$15,000	$12,448	$2,484,264	$2,470,666
8	$0	$15,000	$12,121	$2,499,264	$2,482,787
9	$0	$15,000	$11,802	$2,514,264	$2,494,589
10	$0	$40,000	$30,645	$2,554,264	$2,525,234
11	$0	$15,000	$11,190	$2,569,264	$2,536,423
12	$0	$15,000	$10,895	$2,584,264	$2,547,319
13	$0	$15,000	$10,609	$2,599,264	$2,557,928
14	$0	$15,000	$10,330	$2,614,264	$2,568,258
15	$0	$40,000	$26,823	$2,654,264	$2,595,081
16	$0	$15,000	$9,794	$2,669,264	$2,604,875
17	$0	$15,000	$9,537	$2,684,264	$2,614,411
18	$0	$15,000	$9,286	$2,699,264	$2,623,697
19	$0	$15,000	$9,042	$2,714,264	$2,632,739
20	$0	$40,000	$23,477	$2,754,264	$2,656,216
21	$0	$15,000	$8,573	$2,769,264	$2,664,789
22	$0	$15,000	$8,347	$2,784,264	$2,673,136
23	$0	$15,000	$8,128	$2,799,264	$2,681,264
24	$0	$15,000	$7,914	$2,814,264	$2,689,178
25	$0	$40,000	$20,549	$2,854,264	$2,709,727
26	$0	$15,000	$7,503	$2,869,264	$2,717,231
27	$0	$15,000	$7,306	$2,884,264	$2,724,537
28	$0	$15,000	$7,114	$2,899,264	$2,731,651
29	$0	$15,000	$6,927	$2,914,264	$2,738,578
30	$0	$40,000	$17,987	$2,954,264	$2,756,565
31	$0	$15,000	$6,568	$2,969,264	$2,763,132
32	$0	$15,000	$6,395	$2,984,264	$2,769,527
33	$0	$15,000	$6,227	$2,999,264	$2,775,754
34	$0	$15,000	$6,063	$3,014,264	$2,781,817
35	$0	$40,000	$15,743	$3,054,264	$2,797,560
36	$0	$15,000	$5,749	$3,069,264	$2,803,309
37	$0	$15,000	$5,597	$3,084,264	$2,808,906
38	$0	$15,000	$5,450	$3,099,264	$2,814,356
39	$0	$15,000	$5,307	$3,114,264	$2,819,663
40	$0	$40,000	$13,780	$3,154,264	$2,833,443

Project: GSR Pilot for Shepley's Hill Landfill
Option or Alternative: Alternative A: Barrier Wall/PRB (Red Cove)
Current Date: 3/4/2011

year	up-front cost	annual cost	present value of cost each year	cumulative cash flow	
		(no discounting)	2.7%	no discounting	2.7%
41	$0	$15,000	$5,032	$3,169,264	$2,838,475
42	$0	$15,000	$4,899	$3,184,264	$2,843,374
43	$0	$15,000	$4,770	$3,199,264	$2,848,145
44	$0	$15,000	$4,645	$3,214,264	$2,852,790
45	$0	$40,000	$12,061	$3,254,264	$2,864,851
46	$0	$15,000	$4,404	$3,269,264	$2,869,255
47	$0	$15,000	$4,288	$3,284,264	$2,873,543
48	$0	$15,000	$4,176	$3,299,264	$2,877,719
49	$0	$15,000	$4,066	$3,314,264	$2,881,784
50	$0	$1,040,000	$274,480	$4,354,264	$3,156,265
51	$0	$15,000	$3,855	$4,369,264	$3,160,119
52	$0	$15,000	$3,753	$4,384,264	$3,163,873
53	$0	$15,000	$3,655	$4,399,264	$3,167,528
54	$0	$15,000	$3,559	$4,414,264	$3,171,086
55	$0	$40,000	$9,240	$4,454,264	$3,180,326
56	$0	$15,000	$3,374	$4,469,264	$3,183,701
57	$0	$15,000	$3,285	$4,484,264	$3,186,986
58	$0	$15,000	$3,199	$4,499,264	$3,190,185
59	$0	$15,000	$3,115	$4,514,264	$3,193,300
60	$0	$40,000	$8,088	$4,554,264	$3,201,387
61	$0	$15,000	$2,953	$4,569,264	$3,204,341
62	$0	$15,000	$2,876	$4,584,264	$3,207,216
63	$0	$15,000	$2,800	$4,599,264	$3,210,016
64	$0	$15,000	$2,726	$4,614,264	$3,212,743
65	$0	$40,000	$7,079	$4,654,264	$3,219,822
66	$0	$15,000	$2,585	$4,669,264	$3,222,407
67	$0	$15,000	$2,517	$4,684,264	$3,224,924
68	$0	$15,000	$2,451	$4,699,264	$3,227,374
69	$0	$15,000	$2,386	$4,714,264	$3,229,761
70	$0	$40,000	$6,196	$4,754,264	$3,235,957
71	$0	$15,000	$2,263	$4,769,264	$3,238,219
72	$0	$15,000	$2,203	$4,784,264	$3,240,422
73	$0	$15,000	$2,145	$4,799,264	$3,242,568
74	$0	$15,000	$2,089	$4,814,264	$3,244,656
75	$0	$40,000	$5,423	$4,854,264	$3,250,080
76	$0	$15,000	$1,980	$4,869,264	$3,252,060
77	$0	$15,000	$1,928	$4,884,264	$3,253,988
78	$0	$15,000	$1,878	$4,899,264	$3,255,866
79	$0	$15,000	$1,828	$4,914,264	$3,257,694
80	$0	$40,000	$4,747	$4,954,264	$3,262,441
81	$0	$15,000	$1,733	$4,969,264	$3,264,174

Project: GSR Pilot for Shepley's Hill Landfill
Option or Alternative: Alternative A: Barrier Wall/PRB (Red Cove)
Current Date: 3/4/2011

year	up-front cost	annual cost		present value of cost each year		cumulative cash flow	
		(no discounting)		2.7%		no discounting	2.7%
82	$0	$15,000		$1,688		$4,984,264	$3,265,862
83	$0	$15,000		$1,643		$4,999,264	$3,267,506
84	$0	$15,000		$1,600		$5,014,264	$3,269,106
85	$0	$40,000		$4,155		$5,054,264	$3,273,261
86	$0	$15,000		$1,517		$5,069,264	$3,274,778
87	$0	$15,000		$1,477		$5,084,264	$3,276,255
88	$0	$15,000		$1,438		$5,099,264	$3,277,694
89	$0	$15,000		$1,401		$5,114,264	$3,279,094
90	$0	$40,000		$3,637		$5,154,264	$3,282,731
91	$0	$15,000		$1,328		$5,169,264	$3,284,059
92	$0	$15,000		$1,293		$5,184,264	$3,285,352
93	$0	$15,000		$1,259		$5,199,264	$3,286,611
94	$0	$15,000		$1,226		$5,214,264	$3,287,837
95	$0	$40,000		$3,183		$5,254,264	$3,291,020
96	$0	$15,000		$1,162		$5,269,264	$3,292,183
97	$0	$15,000		$1,132		$5,284,264	$3,293,314
98	$0	$15,000		$1,102		$5,299,264	$3,294,416
99	$0	$15,000		$1,073		$5,314,264	$3,295,490
100	$0	$40,000		$2,786		$5,354,264	$3,298,276

Net Present Value (NPV)-> $3,298,276

*positive dollar value is a "cost", negative dollar value is a "savings"

GSR Team Calculations to Split Energy Results from SiteWise into "Direct" and "Indirect"
Alternative A - Barrier Wall/PRB

phase	Reported by SiteWise: activity	Reported by SiteWise: energy used (MMBTU)	Assigned by GSR Team from SiteWise Output: Scope 1 (direct) energy used (MMBTU)	Assigned by GSR Team from SiteWise Output: Scope 2 (indirect) energy used (MMBTU)	Assigned by GSR Team from SiteWise Output: Scope 3 (indirect) energy used (MMBTU)	Added by GSR Team: Scope 3 (indirect) energy used (MMBTU)	Total Calculated by GSR Team
Wall Installation and Disposal of Excavated Material (Remedial Action Construction tab)	Consumables	8061.12	0.00	0.00	8061.12	0.00	8061.12
	Transportation-Personnel	17.89	0.00	0.00	17.89	4.29	22.18
	Transportation-Equipment	4.12	0.00	0.00	4.12	0.99	5.11
	Equipment Use and Misc	199.41	199.41	0.00	0.00	47.86	247.27
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-total	8282.54	199.41	0.00	8083.13	53.14	8335.68
System O&M (Remedial Action Operations tab)	Consumables	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Equipment	0.00	0.00	0.00	0.00	0.00	0.00
	Equipment Use and Misc	0.00	0.00	0.00	0.00	0.00	0.00
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-total	0.00	0.00	0.00	0.00	0.00	0.00
total		8282.54	199.41	0.00	8083.13	53.14	8335.68

Note: For energy use related to fuel use for transportation or on-site equipment use, SiteWise reports energy use associated with combustion only. The added Scope 3 energy use for these activities take into account upstream energy use (i.e. energy required for extraction, refining, etc.). The added energy is based on multipliers used in the GREET software, version 1.8d.1, which in this case equates to multiplying energy used in fuel combustion by 0.24 to calculate the upstream energy use.

Electricity use reported by SiteWise in units of kWh is "Direct Scope 1", meaning it is energy consumed at the location of the project. However, energy use associated with electricity reported by SiteWise in units of MMBtu is a life-cycle value which also includes a factor to account for energy used elsewhere required to generate the electricity ("Indirect Scope 2"). Here, 33% of the life-cycle value reported by SiteWise is considered to be "Scope 1" on-site energy use, and 67% is considered to be "Scope 2" energy used in electricity generation.

GSR Team Calculations to Split GHG Results from SiteWise into "Direct" and "Indirect"
Alternative A - Barrier Wall/PRB

phase	Reported by SiteWise		Assigned by GSR Team from SiteWise Output			Added by GSR Team	Total Calculated by GSR Team
			Scope 1 (direct)	Scope 2 (indirect)	Scope 3 (indirect)	Scope 3 (indirect)	
	activity	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	
Wall Installation and Disposal of Excavated Material (Remedial Action Construction tab)	Consumables	1039.01	0.00	0.00	1039.01	0.00	1039.01
	Transportation-Personnel	1.62	0.00	0.00	1.62	0.39	2.01
	Transportation-Equipment	0.28	0.00	0.00	0.28	0.07	0.35
	Equipment Use and Misc	12.19	12.19	0.00	0.00	2.93	15.12
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-total	1053.10	12.19	0.00	1040.91	3.38	1056.48
System O&M (Remedial Action Operations tab)	Consumables	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Equipment	0.00	0.00	0.00	0.00	0.00	0.00
	Equipment Use and Misc	680.40	0.00	0.00	680.40	0.00	680.40
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-total	680.40	0.00	0.00	680.40	0.00	680.40
total		1733.50	12.19	0.0000	1721.31	3.38	1736.88

Note: For GHG emissions related to fuel use for transportation or on-site equipment use, SiteWise reports emissions associated with combustion only. The added Scope 3 emissions for these activities take into account upstream emissions (i.e. emissions related to extraction, refining, etc.). The added emissions factor is based on multipliers used in the GREET software, version 1.8d.1, which in this case equates to multiplying emission from fuel combustion by 0.24 to calculate the upstream emissions.

CO2e reported by SiteWise for electricity use is all associated with generation of the electricity ("Indirect Scope 2").

APPENDIX C-5

Alternative B – Barrier Wall (Red Cove)

Appendix C5
Assumptions for SiteWise Input and Other Calculations
Shepley's Hill Pilot GSR Evaluation
Alternative B – Barrier Wall

Alternative B – Barrier Wall – SiteWise "Alternative 6" Directory

- Installation of a 950'*30" soil-bentonite slurry wall
- Disposal of excavated material under the landfill cap
- 100 years of operation

The notes pertaining to SiteWise input are organized by the following sections of SiteWise input:

- Wall Installation and Disposal of Excavated Material – Uses "Remedial Action Construction" tab of SiteWise input for SiteWise "Alternative 6"

- System O&M – Uses "Remedial Action Operations" tab of SiteWise input for SiteWise "Alternative 6"

For each section of SiteWise, all the sections are listed, with pertinent information added only for those sections of the input sheet where data were added.

Other calculations done outside of SiteWise are then presented. These include the following:

- % of total energy from renewable resources
- Hazardous Air Pollutants
- Refined Material Use
- Unrefined Material Use
- Tons of non-hazardous waste
- Risks to on-site works and from transportation
- Heavy truck trips through residential areas

Additional tables are attached which show how SiteWise outputs were split into "direct" and "indirect" energy use and greenhouse gas emissions. For definitions of direct and indirect energy use and emissions, please refer to section 2.2.2 of the evaluation report.

A cost sheet is also attached. Some of the information on the cost sheet comes from Appendix C of the December 2010 Draft FFS (also attached). Information regarding the cost calculations is as follows:

- The capital cost of $1,210,292 is taken from Table C-B of the December 2010 Draft FFS. The costs mainly consist of engineering and oversight for system design, installation of the slurry wall, and disposal of excavated materials under the landfill cap.

- The annual cost of $5,000 per year is taken from Table C-B of the December 2010 Draft FFS.

Alternative B – Description

- Capital costs are assumed to occur in year 0, and annual costs are assumed to occur in years 1 to 100.

- To determine net present value (NPV), a 2.7 percent discount rate is applied to future costs, which is consistent with the discount rate applied in the December 2010 Draft FFS.

- NPV is calculated by discounting future costs to present-day dollars using the following equation:

$$PV = \frac{FV}{(1+i)^n} = C \times FV$$

PV is the present value
FV is the value in year “n” (i.e., future value)
i is the discount rate
C is the discount factor, which equals $1/(1+i)^n$

Alternative B – Wall Installation and Disposal of Excavated Material

<u>Scope of Work (some details not outlined in the FFS are assumed)</u>

- Barrier Wall Installation
  - Table C-B says soil-bentonite slurry wall will be 47,500 ft^2 (length*depth) and 30 inches (2.5 ft) wide, so excavation volume is 118,750 ft^3
- Installation will require sheet pile steel, assume sheet piling and bracing temporary (i.e., not permanent).
- Excavation and transfer to landfill assumed to be done by hydraulic excavator.
- Number of crew days for work is assumed to be approximately equal to the total hours of equipment operation calculated by SiteWise divided by 8 hours per day (SiteWise calculates 10 days) multiplied by "factors" to account for items which will lengthen the time. These factors include:
  - Depth to 50 ft – no factor needed for depth as I n Alternative 4
  - Address sheet piling – multiply by 2 rather than 3 in alternative 4 since depth is less (10 days * 2 = 20 days)
- Crew is assumed to be 2 individuals.
- Equipment – assume one trip to site for one excavator
- Oversight consultant (1 individual riding in a light duty truck)
  - Daily trips (60 days), 40 miles round-trip
- Disposal of excavated materials
  - Remove drainage layer, replace liner and drainage layer over 0.4 acres
  - Transfer and place 1,319 cubic yards of material into new cell

Alternative B – Wall Installation and Disposal of Excavated Material

<u>SiteWise Input – Input into “Remedial Action Construction” tab in SiteWise “Alternative 6”</u>

- Material Production
  - Well Materials
  - Treatment Chemicals & Materials
  - GAC
  - Construction Materials
    - Landfill liner and drainage layer not included (negligible amount of material)
    - Material 1 – Gravel used to represent soil-bentonite slurry mix for barrier wall. 47,500 ft^2 area by 2.5 ft thick
  - Well Decommissioning

- Transportation
  - Personnel Transportation – Road
    - All personnel assumed to be local (~20 miles one way, 40 miles round trip)
    - Trip 1 – Round-trips for 2 person crew for excavation and transfer to landfill. Number of trips calculated by taking total number of equipment operation hours from SiteWise Remedial Action Construction output file, Equipment Use – Earthwork sheet (64.2+19.3=83.5) and dividing by 8 hours per day and rounding result as appropriate (~10 days). As described above, multiply by factor of 2 to account for sheet piling work. Result is estimate of 20 days.
    - Trip 2 – Round-trips for consultant on a daily basis for 20 days.
    - Trip 3 – 1 Excavator, assume 1 round trip to site. Select “heavy duty” for vehicle type and diesel for fuel used.
  - Personnel Transportation – Air
  - Personnel Transportation – Rail
  - Equipment Transportation – Road
    - Trip 1 – Sheet piling and bracing (steel)
      - Assume excavations done in 100 by 20 ft sections, 2 sheet piles (one for each side of trench), 35 lbs/sq. ft, and divide by 2000 to convert lbs to tons (100*20*2*35/2000=70 tons). Average weight per round trip (with empty return trip) is 70/2=35 tons. Since weight carried for an on-road truck cannot exceed 40 lbs, assume 2 round trips with an average of 17.5 lbs (35/2).
      - Sheet piling assumed to be shipped from Boston, MA (~45 miles one way, 90 miles round trip). Multiply the mileage by 2 for 2 round trips (90*2=180).
  - Equipment Transportation – Air
  - Equipment Transportation – Rail
  - Equipment Transportation – Water

- Equipment Use – Equipment use is a hydraulic excavator for excavation and transfer of excavated material to landfill. SiteWise determines the equipment horsepower and bucket size based on total cubic yards excavated. Although this may be appropriate for single, large excavation, it is not necessarily appropriate for trenching. In addition, the productivity rates provided in SiteWise for excavator use do not agree with those provided by RS Means construction data. The Look Up Table in SiteWise Input Sheet.xls was modified to provide a consistent and appropriate equipment size for all trenching. Productivity rates were also updated to be consistent with RS Means construction data.

- Earthwork
  - Equipment 1 – Excavator for 118,750 ft^3 excavation volume for soil-bentonite slurry wall. Divide by 27 to convert from cubic feet to cubic yards (118,750 /27 = 4398 yd^3)
  - Equipment 2 – Excavator for transfer of 1,319 cubic yards of material into new landfill cell.
- Drilling
- Pump operation
- Diesel and Gasoline Pumps
- Blower, Compressor, Mixer, and Other Equipment
- Generators
- Agricultural Equipment
- Capping Equipment
- Mixing Equipment

- Residual Handling
  - Residue Disposal/Recycling
  - Landfill Operations
  - Thermal/Catalytic Oxidizers
  - Water Consumption
  - Landfill Methane Emissions

- Other Known On-Site Activities

Alternative B – System O&M

Scope of Work (some details not outlined in the FFS are assumed)

- Annual O&M – The specific materials, equipment, and labor hours required for this minor O&M ($5,000 per year) are unknown. Therefore, detailed footprinting using SiteWise was not done for this component of this remedial alternative.

Alternative B – System O&M

<u>SiteWise Input – Input into “Remedial Action Operations” tab in SiteWise “Alternative 6”</u>

- Material Production
    - Well Materials
    - Treatment Chemicals & Materials
    - GAC
    - Construction Materials
    - Well Decommissioning

- Transportation
    - Personnel Transportation – Road
    - Personnel Transportation – Air
    - Personnel Transportation – Rail
    - Equipment Transportation – Road
    - Equipment Transportation – Air
    - Equipment Transportation – Rail
    - Equipment Transportation – Water

- Equipment Use
    - Earthwork
    - Drilling
    - Pump operation
    - Diesel and Gasoline Pumps
    - Blower, Compressor, Mixer, and Other Equipment
    - Generators
    - Agricultural Equipment
    - Capping Equipment
    - Mixing Equipment

- Residual Handling
    - Residue Disposal/Recycling
    - Landfill Operations
    - Thermal/Catalytic Oxidizers
    - Water Consumption
    - Landfill Methane Emissions

- Other Known On-Site Activities

Other Supporting Calculations
Shepley's Hill Landfill Pilot GSR Evaluation
Alternative B – Barrier Wall

% of Total Energy Usage from Renewable Resources

- This alternative does not rely on electricity, and no renewable energy is assumed for any of the other energy demands. Thus, none from renewable resources.

Hazardous Air Pollutants

- None for this alternative.

Refined Materials Use

- None for this alternative.

Unrefined Materials Use

Assumptions:

- 950*2.5*50 = 118,750 ft^3 of soil and bentonite = 13,194,444 pounds/2000 = 6597 tons
- 100% virgin material, 0% recycled material

Tons of Non-Hazardous Waste

- None (all excavated material disposed on site).

Tons of Hazardous Waste

- None (all excavated material disposed on site)

Risks to On-Site Workers and from Transportation

- Refer to "Total" tab of the "Summary.xlsx" spreadsheet.
- For transportation related risks, sum injuries and fatalities for all transportation activities
- Add total risk form transportation and non-transportation, and then subtract the transportation sums previously calculated, to get non-transportation.
- For non-transportation risk, need to account for extra hours that were added to account for sheet pile work and depth of excavation. Since SiteWise calculated 10 days of excavation, and we added 10 days, we need to take the SiteWise risks for that task in equipment use and add an additional 1 times that amount to the non-transportation risk.
- For this alternative, the safety risk is higher for equipment use associated with wall construction (0.004) than for transportation (0.002).

Alternative B – Other Calculations

Heavy Truck Trips through Residential Areas

- Project team indicated that trucks could enter through a non-residential route.

Table C-B
Alternative B - Containment Wall

Item	Quantity	Units	Unit Cost	Cost per Event/Year	Non-Discounted Cost	Discounted Cost
Study/Design/Capital Costs						
Design						
Engineering & Oversight	1	job	35%	$280,000	$280,000	$280,000
Installation						
Installation of 950 ft x 30" Soil-Bentonite Slurry Wall	47,500	sq. ft.	$15 / sq. ft.	$712,500	$712,500	$712,500
- Cost includes excavation, slurry mix prep and placement						
Excavated Material Disposal Under Cap						
Remove Drainage Layer, Replace Liner & Drainage Layer	0.4	acres	$95,000 / acre	$38,000	$38,000	$38,000
Transfer & Place Material into New Cell	1,319	cub. yd.	$15 / cub. yd.	$19,792	$19,792	$19,792
Contingency	1	job	20%	$160,000	$160,000	$160,000
Total Capital Costs					**$1,210,292**	**$1,210,292**

O & M Costs	Quantity	Units	Unit Cost	Cost per Event/Year	Non-Discounted Cost	Discounted Cost
Slurry Wall/PRB						
Annual O+M	100	years	$5,000 / yr	$5,000	$500,000	$172,286
Total O&M and Monitoring Costs					**$500,000**	**$172,286**
TOTAL					**$1,710,292**	**$1,382,578**

Discount Rate for Present Value Calculations **2.7%**

Note:

Discount Rate is 30-Year Real Interest Rate from OMB Circular No. A-94 – Appendix C.
Groundwater monitoring included in Alternatives 1-5.

Project: GSR Pilot for Shepley's Hill Landfill (Red Cove)
Option or Alternative: Alternative B: Barrier Wall
Current Date: 3/4/2011

year	up-front cost	annual cost		present value of cost each year		cumulative cash flow	
		(no discounting)		2.7%		no discounting	2.7%
0	$1,210,292	$0		$1,210,292		$1,210,292	$1,210,292
1	$0	$5,000		$4,869		$1,215,292	$1,215,161
2	$0	$5,000		$4,741		$1,220,292	$1,219,901
3	$0	$5,000		$4,616		$1,225,292	$1,224,517
4	$0	$5,000		$4,495		$1,230,292	$1,229,012
5	$0	$5,000		$4,376		$1,235,292	$1,233,388
6	$0	$5,000		$4,261		$1,240,292	$1,237,649
7	$0	$5,000		$4,149		$1,245,292	$1,241,799
8	$0	$5,000		$4,040		$1,250,292	$1,245,839
9	$0	$5,000		$3,934		$1,255,292	$1,249,773
10	$0	$5,000		$3,831		$1,260,292	$1,253,604
11	$0	$5,000		$3,730		$1,265,292	$1,257,333
12	$0	$5,000		$3,632		$1,270,292	$1,260,965
13	$0	$5,000		$3,536		$1,275,292	$1,264,502
14	$0	$5,000		$3,443		$1,280,292	$1,267,945
15	$0	$5,000		$3,353		$1,285,292	$1,271,298
16	$0	$5,000		$3,265		$1,290,292	$1,274,562
17	$0	$5,000		$3,179		$1,295,292	$1,277,741
18	$0	$5,000		$3,095		$1,300,292	$1,280,837
19	$0	$5,000		$3,014		$1,305,292	$1,283,851
20	$0	$5,000		$2,935		$1,310,292	$1,286,785
21	$0	$5,000		$2,858		$1,315,292	$1,289,643
22	$0	$5,000		$2,782		$1,320,292	$1,292,425
23	$0	$5,000		$2,709		$1,325,292	$1,295,134
24	$0	$5,000		$2,638		$1,330,292	$1,297,772
25	$0	$5,000		$2,569		$1,335,292	$1,300,341
26	$0	$5,000		$2,501		$1,340,292	$1,302,842
27	$0	$5,000		$2,435		$1,345,292	$1,305,278
28	$0	$5,000		$2,371		$1,350,292	$1,307,649
29	$0	$5,000		$2,309		$1,355,292	$1,309,958
30	$0	$5,000		$2,248		$1,360,292	$1,312,206
31	$0	$5,000		$2,189		$1,365,292	$1,314,396
32	$0	$5,000		$2,132		$1,370,292	$1,316,527
33	$0	$5,000		$2,076		$1,375,292	$1,318,603
34	$0	$5,000		$2,021		$1,380,292	$1,320,624
35	$0	$5,000		$1,968		$1,385,292	$1,322,592
36	$0	$5,000		$1,916		$1,390,292	$1,324,508
37	$0	$5,000		$1,866		$1,395,292	$1,326,374
38	$0	$5,000		$1,817		$1,400,292	$1,328,190
39	$0	$5,000		$1,769		$1,405,292	$1,329,959
40	$0	$5,000		$1,722		$1,410,292	$1,331,682

Project: GSR Pilot for Shepley's Hill Landfill (Red Cove)
Option or Alternative: Alternative B: Barrier Wall
Current Date: 3/4/2011

year	up-front cost	annual cost	present value of cost each year	cumulative cash flow	
		(no discounting)	2.7%	no discounting	2.7%
41	$0	$5,000	$1,677	$1,415,292	$1,333,359
42	$0	$5,000	$1,633	$1,420,292	$1,334,992
43	$0	$5,000	$1,590	$1,425,292	$1,336,582
44	$0	$5,000	$1,548	$1,430,292	$1,338,131
45	$0	$5,000	$1,508	$1,435,292	$1,339,638
46	$0	$5,000	$1,468	$1,440,292	$1,341,106
47	$0	$5,000	$1,429	$1,445,292	$1,342,536
48	$0	$5,000	$1,392	$1,450,292	$1,343,928
49	$0	$5,000	$1,355	$1,455,292	$1,345,283
50	$0	$5,000	$1,320	$1,460,292	$1,346,602
51	$0	$5,000	$1,285	$1,465,292	$1,347,887
52	$0	$5,000	$1,251	$1,470,292	$1,349,139
53	$0	$5,000	$1,218	$1,475,292	$1,350,357
54	$0	$5,000	$1,186	$1,480,292	$1,351,543
55	$0	$5,000	$1,155	$1,485,292	$1,352,698
56	$0	$5,000	$1,125	$1,490,292	$1,353,823
57	$0	$5,000	$1,095	$1,495,292	$1,354,918
58	$0	$5,000	$1,066	$1,500,292	$1,355,984
59	$0	$5,000	$1,038	$1,505,292	$1,357,022
60	$0	$5,000	$1,011	$1,510,292	$1,358,033
61	$0	$5,000	$984	$1,515,292	$1,359,018
62	$0	$5,000	$959	$1,520,292	$1,359,976
63	$0	$5,000	$933	$1,525,292	$1,360,910
64	$0	$5,000	$909	$1,530,292	$1,361,818
65	$0	$5,000	$885	$1,535,292	$1,362,703
66	$0	$5,000	$862	$1,540,292	$1,363,565
67	$0	$5,000	$839	$1,545,292	$1,364,404
68	$0	$5,000	$817	$1,550,292	$1,365,221
69	$0	$5,000	$795	$1,555,292	$1,366,016
70	$0	$5,000	$775	$1,560,292	$1,366,791
71	$0	$5,000	$754	$1,565,292	$1,367,545
72	$0	$5,000	$734	$1,570,292	$1,368,279
73	$0	$5,000	$715	$1,575,292	$1,368,994
74	$0	$5,000	$696	$1,580,292	$1,369,691
75	$0	$5,000	$678	$1,585,292	$1,370,369
76	$0	$5,000	$660	$1,590,292	$1,371,029
77	$0	$5,000	$643	$1,595,292	$1,371,671
78	$0	$5,000	$626	$1,600,292	$1,372,297
79	$0	$5,000	$609	$1,605,292	$1,372,907
80	$0	$5,000	$593	$1,610,292	$1,373,500
81	$0	$5,000	$578	$1,615,292	$1,374,078

Project: GSR Pilot for Shepley's Hill Landfill (Red Cove)
Option or Alternative: Alternative B: Barrier Wall
Current Date: 3/4/2011

year	up-front cost	annual cost		present value of cost each year		cumulative cash flow	
		(no discounting)		2.7%		no discounting	2.7%
82	$0	$5,000		$563		$1,620,292	$1,374,640
83	$0	$5,000		$548		$1,625,292	$1,375,188
84	$0	$5,000		$533		$1,630,292	$1,375,722
85	$0	$5,000		$519		$1,635,292	$1,376,241
86	$0	$5,000		$506		$1,640,292	$1,376,747
87	$0	$5,000		$492		$1,645,292	$1,377,239
88	$0	$5,000		$479		$1,650,292	$1,377,719
89	$0	$5,000		$467		$1,655,292	$1,378,186
90	$0	$5,000		$455		$1,660,292	$1,378,640
91	$0	$5,000		$443		$1,665,292	$1,379,083
92	$0	$5,000		$431		$1,670,292	$1,379,514
93	$0	$5,000		$420		$1,675,292	$1,379,933
94	$0	$5,000		$409		$1,680,292	$1,380,342
95	$0	$5,000		$398		$1,685,292	$1,380,740
96	$0	$5,000		$387		$1,690,292	$1,381,127
97	$0	$5,000		$377		$1,695,292	$1,381,505
98	$0	$5,000		$367		$1,700,292	$1,381,872
99	$0	$5,000		$358		$1,705,292	$1,382,230
100	$0	$5,000		$348		$1,710,292	$1,382,578

Net Present Value (NPV)-> $1,382,578

*positive dollar value is a "cost", negative dollar value is a "savings"

GSR Team Calculations to Split Energy Results from SiteWise into "Direct" and "Indirect"
Alternative B - Barrier Wall

phase	Reported by SiteWise: activity	Reported by SiteWise: energy used (MMBTU)	Assigned by GSR Team from SiteWise Output: Scope 1 (direct) energy used (MMBTU)	Assigned by GSR Team from SiteWise Output: Scope 2 (indirect) energy used (MMBTU)	Assigned by GSR Team from SiteWise Output: Scope 3 (indirect) energy used (MMBTU)	Added by GSR Team: Scope 3 (indirect) energy used (MMBTU)	Total Calculated by GSR Team
Wall Installation and Disposal of Excavated Material (Remedial Action Construction tab)	Consumables	1590.24	0.00	0.00	1590.24	0.00	1590.24
	Transportation-Personnel	13.92	0.00	0.00	13.92	3.34	17.26
	Transportation-Equipment	4.12	0.00	0.00	4.12	0.99	5.11
	Equipment Use and Misc	163.64	163.64	0.00	0.00	39.27	202.91
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-total	1771.92	163.64	0.00	1608.28	43.60	1815.52
System O&M (Remedial Action Operations tab)	Consumables	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Equipment	0.00	0.00	0.00	0.00	0.00	0.00
	Equipment Use and Misc	0.00	0.00	0.00	0.00	0.00	0.00
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-total	0.00	0.00	0.00	0.00	0.00	0.00
total		1771.92	163.64	0.00	1608.28	43.60	1815.52

Note: For energy use related to fuel use for transportation or on-site equipment use, SiteWise reports energy use associated with combustion only. The added Scope 3 energy use for these activities take into account upstream energy use (i.e. energy required for extraction, refining, etc.). The added energy is based on multipliers used in the GREET software, version 1.8d.1, which in this case equates to multiplying energy used in fuel combustion by 0.24 to calculate the upstream energy use.

Electricity use reported by SiteWise in units of kWh is "Direct Scope 1", meaning it is energy consumed at the location of the project. However, energy use associated with electricity reported by SiteWise in units of MMBtu is a life-cycle value which also includes a factor to account for energy used elsewhere required to generate the electricity ("Indirect Scope 2"). Here, 33% of the life-cycle value reported by SiteWise is considered to be "Scope 1" on-site energy use, and 67% is considered to be "Scope 2" energy used in electricity generation.

GSR Team Calculations to Split GHG Results from SiteWise into "Direct" and "Indirect"
Alternative B - Barrier Wall

phase	Reported by SiteWise		Assigned by GSR Team from SiteWise Output			Added by GSR Team	Total Calculated by GSR Team
			Scope 1 (direct)	Scope 2 (indirect)	Scope 3 (indirect)	Scope 3 (indirect)	
	activity	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	
Wall Installation and Disposal of Excavated Material (Remedial Action Construction tab)	Consumables	95.08	0.00	0.00	95.08	0.00	95.08
	Transportation-Personnel	1.26	0.00	0.00	1.26	0.30	1.56
	Transportation-Equipment	0.28	0.00	0.00	0.28	0.07	0.35
	Equipment Use and Misc	10.00	10.00	0.00	0.00	2.40	12.40
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-total	106.62	10.00	0.00	96.61	2.77	109.39
System O&M (Remedial Action Operations tab)	Consumables	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	0.00	0.00	0.00	0.00	0.00	0.00
	Transportation-Equipment	0.00	0.00	0.00	0.00	0.00	0.00
	Equipment Use and Misc	0.00	0.00	0.00	0.00	0.00	0.00
	Residual Handling	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-total	0.00	0.00	0.00	0.00	0.00	0.00
total		106.62	10.00	0.0000	96.61	2.77	109.39

Note: For GHG emissions related to fuel use for transportation or on-site equipment use, SiteWise reports emissions associated with combustion only. The added Scope 3 emissions for these activities take into account upstream emissions (i.e. emissions related to extraction, refining, etc.). The added emissions factor is based on multipliers used in the GREET software, version 1.8d.1, which in this case equates to multiplying emission from fuel combustion by 0.24 to calculate the upstream emissions.

CO2e reported by SiteWise for electricity use is all associated with generation of the electricity ("Indirect Scope 2").

FINAL REPORT

PILOT PROJECT
GREEN AND SUSTAINABLE REMEDIATION EVALUATION: SHEPLEY'S HILL LANDFILL – CONSTRUCTABILITY PHASE

Former Fort Devens Army Installation, Devens, MA

Prepared for:

U.S. Army Corps of Engineers
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Contract No. W912DQ-08-D-0019
Delivery Order No. ZW02

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10 April 2012

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PREFACE

The US Army Engineering and Support Center, Huntsville (USAESCH), Environmental and Munitions Center of Expertise (EM CX) has contracted Tetra Tech EC, Inc. (Tetra Tech) under Contract W912DQ-08-D-0019, Delivery Order No. ZW02, to conduct and document a Study that follows the process of considering, incorporating, documenting, and evaluating the benefits of green and sustainable remediation (GSR) practices. The objective of this Task Order is to: (1) Follow the consideration and incorporation of GSR practices into Army environmental remediation projects; (2) Ascertain the effectiveness of the GSR practices that are considered and incorporated; and (3) Provide procedures by which GSR practices that are shown to be effective can be identified, considered, implemented and documented by Project Teams working on Army sites. The information obtained from this Study will be used to provide recommendations to the Office of the Assistant Chief of Staff for Installation Management (OACSIM) for development of Army-wide GSR guidance and policy. This document has been prepared in accordance with the Task Order Statement of Work (SOW) entitled "*Evaluation of Consideration and Incorporation of Green and Sustainable Remediation (GSR) Practices in Army Environmental Remediation*" (26 July 2010).

The Project Delivery Team (PDT) consists of representatives and subject matter experts (SMEs) from the following organizations:

- EM CX;
- OACSIM;
- National Guard Bureau (NGB);
- Army Environmental Command (AEC);
- Tetra Tech;
- Office of the Deputy Assistant Secretary of the Army-Environment, Safety, and Occupational Health (ODASA (ESOH));
- Headquarters US Army Corps of Engineers (HQ USACE) Formerly Used Defense Sites (FUDS) program;
- HQ USACE Environmental Community of Practice (ECoP) Military Munitions Support Services (M2S2);
- Huntsville Center Environmental Program; and
- Army Environmental Policy Institute (AEPI)

Specific representatives of those organizations are listed on the table at the end of this preface. This report pertains to one of the pilot projects conducted as part of the Study. Tetra Tech personnel who provided the most significant contributions to this report are as follows:

- Preparation
  - Rob Greenwald (Project Manager)
  - Sarah Farron
  - Sandra Goodrow

- Review
  - Doug Sutton (IRP GSR Technical Lead)

Sincere thanks are extended to the Project Team associated with this pilot project, for their willingness to participate in this Study and for their efforts that were associated with their participation.

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4/10/12

Date

ACRONYMS AND ABBREVIATIONS

ACSIM	Assistant Chief of Staff for Installation Management
AEC	Army Environmental Command
AEPI	Army Environmental Policy Institute
BMPs	Best Management Practices
BRAC	Base Realignment and Closure
CB	Cement Bentonite
CO2	Carbon dioxide
CO2e	Equivalent Global Warming Potential of Carbon Dioxide
CSM	Conceptual Site Model
DoD	Department of Defense
ECoP	Environmental Community of Practice
EM CX	Environmental and Munitions Center of Expertise
ESOH	Environment, Safety, and Occupational Health
FFS	Focused Feasibility Study
FUDS	Formerly Used Defense Sites
GHG	Greenhouse gas
gpm	Gallons per minute
GSR	Green and Sustainable Remediation
HQ USACE	Headquarters US Army Corps of Engineers
HRS	Hours
IRP	Installation Restoration Program
Kg	Kilograms
lbs	Pounds
M2S2	Military Munitions Support Services
MMBtu	Million Metric British Thermal Units
MMRP	Military Munitions Response Program
NGB	National Guard Bureau
NOx	Nitrogen Oxides
NPV	Net present value
O&M	Operations and Maintenance
OACSIM	Office of the Assistant Chief of Staff for Installation Management
ODASA	Office of the Deputy Assistant Secretary of the Army
P&T	Pump and Treat
PDT	Project Delivery Team
PM	Particulate Matter
PVC	Polyvinyl Chloride
RECs	Renewable Energy Certificates
ROD	Record of Decision
RSE	Remediation System Evaluation
SB	Soil Bentonite
SiteWise	Battelle SiteWise™ Sustainable Environmental Remediation Tool
SMEs	Subject matter experts
SOW	Statement of Work
SOx	Sulfur Oxides
US	United States
USACE	United States Army Corps of Engineers
USAESCH	US Army Engineering and Support Center, Huntsville

1.0 INTRODUCTION

1.1 ACSIM GSR STUDY AND PURPOSE OF THIS GSR EVALUATION

The US Army Engineering and Support Center, Huntsville (USAESCH), Environmental and Munitions Center of Expertise (EM CX) has contracted Tetra Tech EC, Inc. (Tetra Tech) under Contract W912DQ-08-D-0019, Delivery Order No. ZW02, to conduct and document a Study that follows the process of considering, incorporating, documenting, and evaluating the benefits of green and sustainable remediation (GSR) practices (hereafter referred to as "the Study"). Pursuant to the Department of Defense (DoD) Memorandum "*Consideration of Green and Sustainable Remediation Practices in the Defense Environmental Restoration Program*" (DoD, 2009), GSR employs strategies throughout the remedial process that:

- Use natural resources and energy efficiently;
- Reduce negative impacts on the environment;
- Minimize or eliminate pollution at its source;
- Protect and benefit the community at large; and
- Reduce waste to the greatest extent possible.

The objective of the Study is to: (1) Follow the consideration and incorporation of GSR practices into Army environmental remediation projects; (2) Ascertain the effectiveness of the GSR practices that are considered and incorporated; and (3) Provide procedures by which GSR practices that are shown to be effective can be identified, considered, implemented and documented by project teams working on Army sites. The information obtained from this Study will be used to provide recommendations to the Office of the Assistant Chief of Staff for Installation Management (OACSIM) for development of Army-wide GSR guidance and policy.

One component of the Study is to perform a GSR evaluation at 12 Army "Pilot Projects" that are in various phases of the remedial process. This report presents the Pilot Project GSR Evaluation for the Shepley's Hill Landfill (Constructability Phase) at the Former Fort Devens Army Installation, Devens, MA (hereafter referred to as "Shepley's Hill Landfill"). Specifically, this GSR evaluation pertains to the preliminary constructability of a barrier wall to be installed between the closed landfill and Plow Shop Pond. One of the other Pilot Projects performed for this Study also involved the Shepley's Hill Landfill, and that Pilot Project was performed during the Draft Focused Feasibility Study (Draft FFS) Phase. That previous GSR evaluation included a footprinting evaluation for a barrier wall between the closed landfill and Plow Shop Pond, but that was based on very general information available during the Draft FFS phase. The GSR evaluation (Constructability Phase) presented herein incorporates more detailed information that is now available based on preliminary design activities.

This GSR evaluation has been conducted using an approach developed during the Study and documented in the following report: *Process for Consideration and Incorporation of Green and Sustainable Remediation (GSR) Practices in Army Environmental Remediation (final report dated 26 May 2011).* One purpose for the pilot projects is to provide testing of the GSR approach developed during the Study. That approach will be refined and finalized later in the Study based on lessons learned from this and other pilot projects. In addition, it is anticipated that this GSR evaluation may provide the Project Team for Shepley's Hill Landfill with information and/or recommendations that will be beneficial for their project.

This report refers to “teams” that are defined as follows:

- Study Team: This is the team conducting the Study being led by USACE EM CX that follows the process of considering, incorporating, documenting, and evaluating the benefits of green and sustainable remediation practices for Army projects.

- Project Team: Refers to those associated with implementation of the remedial process for the pilot projects.

- GSR Team: Refers to the personnel that perform a specific GSR evaluation. For this Study, the GSR Team consists of personnel from Tetra Tech, which is a contractor to USACE for the Study.

In this Study, an “EM CX liaison” for each of the pilot projects serves as a bridge between the USACE Study project manager (Carol Dona), the Study contractor performing the GSR evaluation (Tetra Tech), and the Project Team manager for the specific pilot. For this pilot project the EM CX Liaison is Dave Becker.

1.2 TECHNICAL OVERVIEW

1.2.1 Overview of Site Location, Setting, and Contamination

Shepley’s Hill Landfill encompasses approximately 84 acres in the northeast corner of the main post of the former Fort Devens (Figure 1), which is located approximately 35 miles northwest of Boston, Massachusetts. The landfill is bordered to the northeast by Plow Shop Pond, to the west by Shepley’s Hill, to the south by recent commercial development, and to the east by land formerly containing a railroad roundhouse. Nonacoicus Brook, which drains the pond, lies to the north of the landfill.

The primary contaminant in groundwater is arsenic. Groundwater impacted by arsenic flows predominantly to the north and some groundwater impacted by arsenic also flows to the east towards the Red Cove area of Plow Shop Pond.

1.2.2 Remedial Phase and Status

A pump-and-treat (P&T) system was implemented in 2006 as an interim contingency remedy under the 1995 Record of Decision (ROD). The P&T system has been operating since March 2006, and the combined pumping rate from the two extraction wells at the north end of the landfill was increased from 25 to 50 gpm in 2007.

Earlier in the Study, a Draft Focused Feasibility Study (Draft FFS), dated December 2010, was provided to the GSR Team for an initial GSR evaluation (Draft FFS Phase) for alternatives to the current P&T system, and that Draft FFS also presented two alternatives to address groundwater flux to Red Cove (a barrier wall with a permeable reactive portion, or a barrier wall alone). The Draft FFS was subsequently revised, and overall remedy selection has not yet occurred. However, a barrier wall between the closed landfill and Plow Shop Pond is expected to be a component of the selected remedy, and the Project Team has initiated constructability investigations for that barrier wall (including plans for a pre-construction field investigation related to that barrier wall).

The GSR Team was provided with the *Shepley's Hill Landfill Pre-Construction Investigation Workplan* (dated November 2011) and the *Draft Constructability Basis Report, Hydraulic Barrier Wall at Shepley's Hill Landfill* (dated 21 October 2011). A profile of the proposed barrier wall is illustrated in Figure 2, and the locations for the pre-construction investigation are illustrated on Figure 3. The pre-construction investigation (described in more detail in Appendix B of the GSR evaluation) includes drilling of six exploratory borings (identified as SHM-11-01 through SHM-11-06), with SHM-11-02 completed as a bedrock well and SHM-11-06 completed as an overburden well. A minimum 10-foot long rock core sample will be collected at each of these locations, with groundwater profiling for arsenic concentrations conducted at 10-foot sampling increments at locations SHM-11-02 and SHM-11-06. Additionally, two piezometers, identified as SHM-11-07 and SHM-11-08, will be installed to west of the proposed barrier wall location. Prior to implementing the exploration program, a geophysical survey will be performed to map the surface of bedrock along the path of the proposed barrier wall.

This GSR evaluation (Constructability Phase) pertains specifically to the barrier wall between the closed landfill and Plow Shop Pond (and the related pre-construction investigation), and was conducted based on information provided in the Pre-Construction Investigation Workplan and the Draft Constructability Basis Report, supplemented with information from the December 2010 Draft FFS when necessary. The GSR evaluation was performed in the "pre-construction phase", prior to final remedy selection. The schedule of the GSR evaluation was expedited in order to fit within the schedule of the overall Study.

This GSR evaluation considers the following constructability alternatives described in the Draft Constructability Basis Report:

- Baseline: Soil Bentonite (SB) Slurry Wall (recommended alternative by the Project Team)
- Alternative 1: Cement Bentonite (CB) Slurry Wall
- Alternative 2: Grouted Sheet Pile Wall

This GSR evaluation provides an evaluation of the alternatives listed above with respect to specific GSR metrics, and also highlights how specific GSR Best Management Practices (BMPs) have been implemented in the slurry wall design and/or could be incorporated into construction. However, this GSR evaluation does not in any manner include an evaluation or judgment of the protectiveness of any of these alternatives. The calculated footprints for the barrier wall in this evaluation would be expected to differ from those presented in the previous GSR evaluation (Draft FFS Phase) because more detailed information is available based on the preliminary constructability activities.

1.3 DOCUMENTS REVIEWED AND CALLS/MEETINGS CONDUCTED

The following project documents were reviewed for this evaluation:

- *Shepley's Hill Landfill Pre-Construction Investigation Workplan* (dated November 2011)
- *Draft Constructability Basis Report, Hydraulic Barrier Wall at Shepley's Hill Landfill* (dated 21 October 2011)
- *Final GSR Evaluation (Draft FFS Phase)* (Tetra Tech, March 2011)
- *Draft Focused Feasibility Study* (Sovereign Consulting, December 2010)

Note that the December 2010 Draft Focused Feasibility Study is referenced here because that document served as the basis for the previous GSR evaluation conducted during the Draft FFS phase. There was subsequent revision to the Draft FFS after that GSR evaluation was performed.

The GSR approach being implemented in the Study typically includes an introductory conference call (referred to as the "Step 3" call) to introduce the Project Team to the Study, to arrange for transfer of information to the GSR Team, and to schedule a more detailed "Step 5" call. Since a Step 3 call had already been conducted with the Shepley's Hill Landfill Project Team for the earlier GSR evaluation (Draft FFS Phase), a "study status call" was conducted on 25 August 2011, in place of the typical "Step 3" call, to confirm that a second GSR evaluation would be performed and that the Project Team could provide the necessary information for the evaluation. Table 1-1 lists the participants of that call.

Table 1-1
Study Status Call Participants, 25 August 2011

Participants			
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A more detailed conference call, referred to as the "Step 5" conference call, was not conducted for this pilot project. Typically during this call the GSR Team uses the list of GSR BMPs developed for the Study as an outline to ask questions to the Project Team and allow the Project Team to provide pertinent information to the GSR Team. In lieu of this call, the Project Team provided "redlined" comments on the BMP checklist that was filled out by the GSR Team. The BMP checklist, including updates based on Project Team comments, is included as Appendix A.

1.4 STRUCTURE OF THIS REPORT

This GSR evaluation report is structured as follows:

- Section 1: Introduction
- Section 2: Key GSR Findings
    - Review of BMPs
    - Quantitative Footprint Analysis for Soil Bentonite Slurry Wall (Baseline)
    - Quantitative Footprint Analysis for Potential Alternatives to the Baseline

        - Alternative 1 – Cement Bentonite Slurry Wall
        - Alternative 2 – Grouted Sheet Pile Wall
    - Comparison of Key Footprints for Baseline versus Alternatives
    - Comparison of Footprinting between Draft FFS Phase and Constructability Phase
    - Other Qualitative Considerations
- Section 3: GSR Recommendations

Supporting information and calculations for quantitative aspects of the evaluation are provided in appendices, and spreadsheet files for the SiteWise tool are attached electronically.

2.0 KEY GSR FINDINGS

2.1 REVIEW OF BEST MANAGEMENT PRACTICES (BMPs)

2.1.1 BMP Tables Completed by GSR Team

Typically, the GSR Team and the Project Team use a list of GSR BMPs as an outline to exchange information and ideas pertinent to application of GSR practices during the Step 5 call. For this evaluation, a Step 5 call was not conducted. Instead, the GSR Team has completed the BMP tables included in Appendix A based on knowledge of the site from the previous GSR evaluation (Draft FFS phase), data provided by the Project Team in the form of documents, and the Project Team's redlined edits and comments on the "pre-draft" report including the draft BMP tables in Appendix A.

Table 2-1 summarizes information entered on the BMP tables in Appendix A, specifically with respect to the number of BMPs that appear to be applicable for this pilot project, the number of BMPs that appear to be practical for this pilot project, the number of BMPs that have been implemented prior to this GSR evaluation, and the number of BMPs that may be associated with potential cost savings.

Table 2-1
Summary of BMP Applicability and Implementation from BMP Tables in Appendix A

	BMP Category								
	A. Planning	B. Characterization and/or Remedy Approach	C. Energy/Emissions Transportation	D. Energy/Emissions Equipment Use	E. Materials & Off-site Services	F. Water Resource Use	G. Waste Generation, Disposal, and Recycling	H. Land Use, Ecosystems, and Cultural Resources	I. Safety and Community
Total Number of BMPs	10	9	4	11	5	5	6	7	7
Number of Applicable BMPs	8	5	3	2	3	4	3	1	6
Number of Practical BMPs	5	4	2	1	2	0	2	0	2
Number of BMPs Implemented Prior to GSR Evaluation									
- Fully	2	4	2	1	2	0	2	0	2
- Partially	2	0	0	0	0	0	0	0	0
- Not Yet	1	0	0	0	0	0	0	0	0
Number of Practical BMPs Likely to Result in Cost Savings	2	1	1	1	2	0	2	0	1

2.1.2 Key Findings Regarding BMPs

An overview of key findings regarding application of the BMPs to this pilot project (Barrier Wall – Constructability Phase) is provided below.

- Examples of GSR BMPs already considered or incorporated include (but are not limited to) the following:
    - Efforts will be made to reduce the number of trips for field work and to couple jobs when possible.
    - The soil bentonite slurry wall that is preferred by the Project Team over either a cement bentonite slurry wall or a steel sheet pile wall uses less refined material (soil rather than cement or steel, and soil is less refined than cement or steel).
    - To the maximum extent possible, excavated soils will be used for the construction of the slurry wall to minimize need to import materials. This will also minimize waste and disposal.
    - The number of trips for waste disposal will be reduced/eliminated because any waste, including any excess excavated soil, will be disposed of in the on-site landfill instead of off-site landfill disposal.
    - The project will benefit the local economy. Personnel will use local hotels and eat in local restaurants.
    - A great deal of effort has already been made in updating the CSM as a basis for remedy decisions, and the proposed pre-construction investigation will aid in further developing the CSM.
    - Sampling during well construction and borehole drilling has been developed based on the intended purpose of each drilling location. For example, blow counts, split spoons, rock cores and groundwater samples will not be collected at proposed piezometer locations because these wells are only intended for water level monitoring.
- The GSR Team suggests several BMPs that the Project Team could consider moving forward. Some examples include the following:
    - Include a GSR section in final design summarizing GSR considerations that were incorporated into the barrier wall design.
    - Indicate in the final design if there are specific scheduling considerations or constraints (e.g., seasons) that should be taken into account to avoid construction delays and/or maximize construction efficiency.
    - In the final design indicate the most likely location for obtaining materials and equipment, and indicate if they are being obtained from the closest feasible locations.
    - Evaluate in more detail the feasibility for using water from Plow Shop Pond or P&T system effluent rather than potable water from a fire hydrant.

- Indicate in the final design what chemicals will be used for cleaning equipment, and document that the selection of chemicals was based on consideration of lowest toxicity to site workers and/or habitat (e.g., runoff to Plow Shop Pond).

- Indicate in the final design what soil erosion control measures will be implemented to protect Plow Shop Pond.

- Indicate in the final design that potential constraints to construction with respect to potential disturbances to the surrounding community (e.g., noise, light, odor, visual) have been considered (and addressed if any are identified).

- Indicate in final design any clauses that might be included in the construction contract to promote GSR considerations (e.g., to avoid excessive idling of equipment).

- The Project Team identified that some BMPs are not practical to implement because of other project-specific constraints. Examples include the following:

    - Given the nature of the work that is expected to be performed (i.e., specialized contractor for slurry wall construction), qualifications of the contractor will likely take precedence over GSR considerations with respect to contractor procurement or reductions in travel distances for personnel and equipment.

    - Purchasing Renewable Energy Certificates (RECs) to offset footprints associated with fuel use during construction is not considered to be practical because it increases costs. Cost is seen as a higher priority by the Project Team.

    - It is unlikely that off-site wastes and/or recycled materials would be identified to use for the barrier wall.

    - Using existing on-site structures during barrier wall construction is not feasible at this site. The current P&T building cannot be used for a "command center" for the remedial activities, so construction trailers will need to be rented.

2.2 QUANTITATIVE FOOTPRINT ANALYSIS FOR SOIL BENTONITE SLURRY WALL (BASELINE SCENARIO)

According to the *Shepley's Hill Landfill Pre-Construction Investigation Workplan* (dated November 2011) and the *Draft Constructability Basis Report, Hydraulic Barrier Wall at Shepley's Hill Landfill* (dated 21 October 2011), it is expected that the selected remedy for the site will include installation of a barrier wall to the east of the existing landfill, between the landfill and Plow Shop Pond. The purpose of the barrier wall is to mitigate the flux of arsenic to Plow Shop Pond by diverting groundwater flow to the north. The barrier wall is intended to have a hydraulic conductivity of 1×10^{-7} cm/sec or less, and have a minimum design life of 100 years. The site consultant (AMEC) indicated in the *Draft Constructability Basis Report* that a soil bentonite (SB) slurry wall is preferred versus other options (cement bentonite slurry wall or sheet piling) on the basis of cost as well as other sustainability considerations such as reducing waste and carbon footprint. Therefore, the SB slurry is considered the "baseline scenario" for this GSR evaluation.

The GSR Team reviewed the information in the documents listed above and developed input to the SiteWise 2.0 tool for quantitative footprinting. Additional input values were provided directly by the Project Team (in cases where these values differed from what was indicated in the documents listed above, the values provided by the Project Team were used). A summary of the how that information was entered into SiteWise is provided in Appendix B.

2.2.1 Overview of Baseline Scenario

For the purposes of footprinting, this alternative is assumed to involve the following components:

- A pre-construction constructability investigation
- Soil Bentonite (SB) barrier wall construction
- Barrier wall O&M (minimal cost of $5,000 per year estimated in the FFS, no other specific footprints for O&M were calculated)

Cost calculations are based on cost information provided in the December 2010 Draft FFS (in which the barrier wall remedy was identified as "Alternative B: Containment Wall"), since no updated costs were included in the constructability work plan. A summary cost sheet developed by the GSR Team is included in Appendix B. Information regarding the cost calculations is as follows:

- The capital cost is $1,210,292 and occurs in year 0.
- The annual operating cost is $5,000, occurring each year in years 1 through 100.
- The sum of capital and annual costs, non-discounted, is $1,710,292.
- To determine net present value (NPV), a 2.7 percent discount rate is applied to future costs, which is consistent with the discount rate applied in the December 2010 Draft FFS. NPV is calculated by discounting future costs to present-day dollars using the following equation:

$$PV = \frac{FV}{(1+i)^n} = C \times FV$$

PV is the present value
FV is the value in year "n" (i.e., future value)
i is the discount rate
C is the discount factor, which equals $1/(1+i)^n$

- The NPV calculated by the GSR Team is $1,382,578.

2.2.2 Summary of Quantitative Footprint Results, Baseline Scenario

Table 2-2 summarizes the quantitative footprint results for the baseline alternative. Input to the SiteWise tool and other supporting calculations are described in Appendix B. The SiteWise files utilized for this portion of the analysis are supplied electronically (SiteWise directory "RA_Baseline_NoFR_1").

Table 2-2 divides total energy use and global warming potential into "direct" and "indirect" use and emissions. The following definitions are utilized for "direct" versus "indirect" energy use and global warming potential:

- Direct Scope 1: From sources that are owned or controlled by the reporting entity.

- Indirect Scope 2: Due to activities of the reporting entity, but occur at sources owned or controlled by another entity, from consumption of purchased electricity, heat or steam.

- Indirect Scope 3: Due to activities of the reporting entity, but occur at sources owned or controlled by another entity, other than Scope 2 (such as the extraction and production of purchased materials and fuels, transport-related activities in vehicles not owned or controlled by the reporting entity, outsourced activities, waste disposal, etc.

SiteWise reports total energy use and total global warming potential, but does not split the "direct" and "indirect" components. The user needs to track the distinction between "direct" and "indirect" components separately, based on information contained within the SiteWise spreadsheets. The separation of the total energy and global warming potential is documented in Appendix B, which describes SiteWise input and related calculations.

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Table 2-2
Summary of Quantitative Footprint for Soil Bentonite Slurry Wall (Baseline)

GSR Parameter	Unit	Value (total)
Environmental		
Energy – Total	MMBtu	5,905
Energy – Direct Scope 1	MMBtu	2,032
Energy – Indirect Scope 2	MMBtu	0
Energy – Indirect Scope 3	MMBtu	3,873
% of Energy from Renewable Resources	%	0%
Global warming potential – Total	Metric tons CO2e	452
Global warming potential – Direct Scope 1	Metric tons CO2e	185
Global warming potential – Indirect Scope 2	Metric tons CO2e	0
Global warming potential – Indirect Scope 3	Metric tons CO2e	267
Criteria air pollutant emissions	Metric tons (NOx+SOx+PM)	1.84
Hazardous air pollutant emissions	Lb	0
Potable water use	1,000s of gallons	3,500
Other water use	1,000s of gallons	Negligible
Refined materials use	Lbs	3,428
% of refined materials from recycled material	%	0
Unrefined materials use	Ton	6,533
% of unrefined materials from recycled material	%	0
Non-hazardous waste generation	Ton	0
Hazardous waste generation	Ton	0
% of potential waste that is recycled or re-used	%	Not determined
Land transferred or made available for beneficial use	Acres	0
Existing ecosystem destruction	Acres	Not quantified
Time frame for land re-use	Years	Not determined
Flexibility and breadth of options for re-use*	see below	Not determined
Economic		
Life-cycle Cost, Discounted (2.7% discount rate)	$	$1.4 M**
Life-cycle Cost, Undiscounted	$	$1.7 M**
Up-front Cost	$	$1.2 M**
Societal		
Predicted number of injuries or fatalities for On-Site Worker	Number of injuries or fatalities	0.003
Predicted number of injuries or fatalities associated with transportation	Number of injuries or fatalities	0.02
One-Way Heavy Vehicle Trips through Res. Area	Trips	None

**Scale for flexibility and breadth of re-use options (greater GSR value with lower number, indicating more breadth and flexibility for potential re-use)*

1 - Unlimited re-use options

2 - Limited re-use options

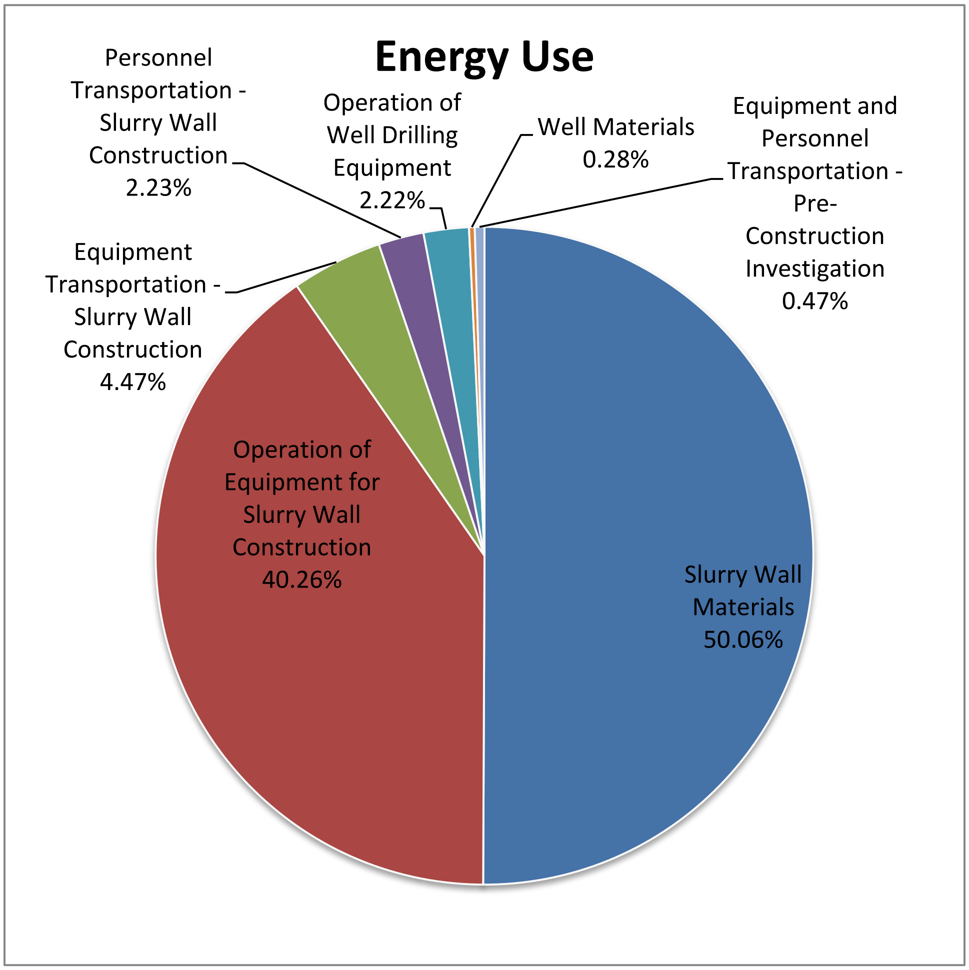
3 - Only one re-use option

*** Based on cost info in December 2010 Draft FFS (no updated costs provided in constructability work plan). Annual O&M costs are $5,000 per year (undiscounted) for 100 years. Discount rate of 2.7% was utilized in December 2010 Draft FFS.*

2.2.3 Key Findings from Quantitative Footprint Analysis, Baseline Scenario

Observations and finding based on the quantitative footprinting results from SiteWise include the following:

- The primary contributors to total energy use for the soil bentonite slurry wall (Baseline) are illustrated on the graphic below and are summarized as follows:

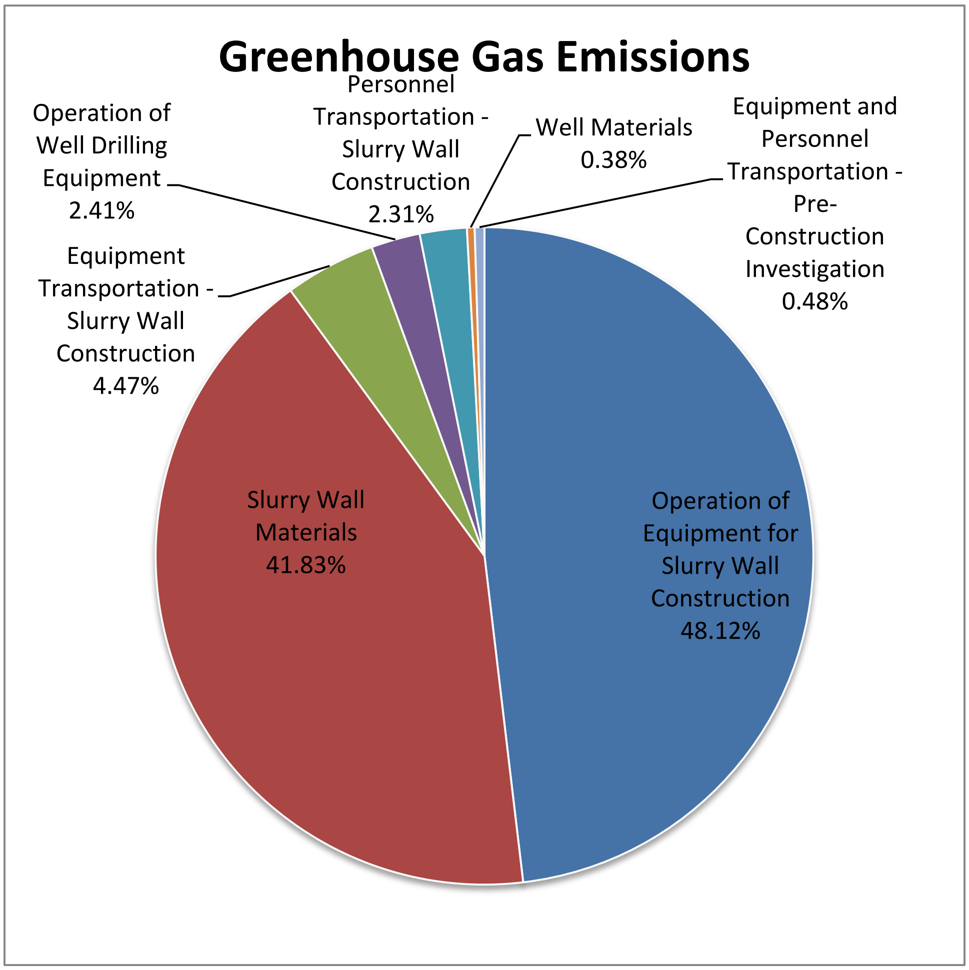


  - Approximately 50% of the total energy use (2,956 MMBtus) is for production of the materials associated with the slurry wall construction
    - 1,032 MMBtus associated with bentonite borrow for excavation and backfill
    - 951 MMBtus associated with sand/gravel borrow for working platform
    - 784 MMBtus associated with plastic fines for soil bentonite backfill
    - 168 MMBtus for soil to cover the extended landfill cap
    - 22 MMBtus for the PVC liner for the extended landfill cap

  - Approximately 40% of the total energy use (2,377 MMBtus) is for operation of construction equipment for slurry wall installation. Calculated energy consumption for this equipment is based on a total fuel consumption of 500 gallons of diesel per day estimated by the Project Team.

- Approximately 4.5% of the total energy use (264 MMBtus) is for the transportation of equipment used for the construction of the soil bentonite slurry wall.
- Approximately 2.2% of the total energy use (132 MMBtus) is for transportation of personnel for the construction of the soil bentonite slurry wall.
- The remaining energy use (3.0% of the total energy use, or 176 MMBtus) results from the combined activities for the pre-construction investigation (well drilling, production of well materials, and transportation of personnel and equipment for those activities).
- No electricity use is calculated for these remedial activities, and it is assumed that no renewable energy will be used for these remedial activities.

- The primary contributors to global warming potential for the soil bentonite slurry wall (Baseline) are illustrated on the graphic below and are summarized as follows:



- Approximately 48% of the total CO_2e (217.5 metric tons) is associated with operation of equipment for the slurry wall construction. Calculated CO_2e emissions for this equipment are based on a total fuel consumption of 500 gallons of diesel per day estimated by the Project Team.

- Approximately 42% of the total CO_2e (189 metric tons) is associated with the production of materials associated with the slurry wall construction
  - 80 metric tons CO_2e associated with bentonite borrow for excavation/backfill
  - 57 metric tons CO_2e associated with sand/gravel borrow for working platform
  - 42 metric tons CO_2e associated with plastic fines for soil bentonite backfill
  - 9 metric tons CO_2e for soil to cover the extended landfill cap
  - 1 metric ton CO_2e for the PVC liner for the extended landfill cap

- Approximately 4.5% of the total CO_2e (20 metric tons) is associated with the transportation of the equipment used for the construction of the soil bentonite slurry wall.

- The remaining greenhouse gas emissions (5.6% or 25 metric tons CO_2e) result from the combined activities for the pre-construction investigation and the transportation of personnel for the slurry wall construction).

- With respect to the energy use and greenhouse gas emissions, the majority (on the order of 60 to 65%) are "Indirect Scope 3", because they are associated with off-site generation of materials and transportation of materials, personnel and equipment. The rest are "Direct Scope 1" associated with on-site fuel usage for equipment. No "Indirect Scope 2" energy use or greenhouse gas emissions are noted because there is no electricity use associated with this remedy.

- The total criteria pollutant emissions (NO_x plus SO_x plus PM) are approximately 1.84 metric tons. The majority calculated by SiteWise is for the on-site equipment use. It is important to note, however, that SiteWise does not calculate criteria pollutant emissions for materials production, which was a significant contributor for energy use and greenhouse gas.

- The remedy is estimated to require 3,500,000 gallons of water. For this GSR evaluation it has been assumed that this is potable water (from a hydrant). The Project Team has identified that it is possible that this water could alternatively come from Plow Shop Pond or from effluent associated with the current P&T system (both of which are likely characterized as non-potable).

- Refined materials use (3,428 lbs) is dominated by cement, and is summarized below:

  - 1,898 lbs — Cement (grout for wells and boreholes)
  - 701 lbs — Steel (well casing)
  - 829 lbs — PVC (well casing and extension of landfill liner)

- Unrefined materials use (6,533 tons) is summarized below:

  - 3,678 tons — Sand/gravel borrow (for working platform)
  - 2,023 tons — Plastic fines (backfill)
  - 432 tons — Soil (cover for cap extension)
  - 400 tons — Bentonite (borrow for trench)
  - 0.1 tons — Sand (filter packs)
  - 0.1 tons — Bentonite (seal on wells)

- No waste is assumed for this remedy. The Project Team indicates that any waste generated from remedy activities is anticipated to remain on-site (placed under the existing landfill cap, using equipment that will already be mobilized to the site) and therefore would not contribute to additional landfill usage in an off-site landfill.

- The Project Team indicates that excess soil cuttings from the excavation will be used in the construction of the slurry wall to the extent possible. However, the GSR Team cannot estimate the percentage allocated for reuse from the information provided.

- The total costs, which were estimated in the December 2010 Draft FFS, are dominated by up-front costs in Year 0, with the rest of the costs allocated to 100 years of minor O&M (see cost sheet in Appendix B). To calculate the discounted life-cycle cost over 100 years, a 2.7% discount rate is applied (this was the discount rate used in the December 2010 Draft FFS).

  - Year 0: capital costs of $1.2 M
  - Year 1-100: annual costs of 5,000 per year

2.3 QUANTITATIVE FOOTPRINT ANALYSIS FOR ALTERNATIVE 1 – CEMENT BENTONITE SLURRY WALL

2.3.1 Overview of Alternative 1

This alternative utilizes a cement bentonite (CB) barrier wall rather than a SB barrier wall (baseline). For the purposes of footprinting, this alternative is assumed to involve the following components:

- A pre-construction constructability investigation

- CB barrier wall construction

- Barrier wall O&M (minimal cost of $5,000 per year estimated in the Draft FFS, no other specific footprints for O&M were calculated)

Note that the *Draft Constructability Basis Report* contains fewer details regarding the construction of the CB barrier wall versus the more detailed information provided for the SB slurry wall. For the purpose of footprinting, the GSR Team assumes that approximately 1,300 cubic yards of cement will be required for the CB slurry wall in place of 35% imported plastic fines/clay for the SB slurry wall in the baseline, which is estimated by the Project Team to require 1,300 cubic yards of clay (Draft Constructability Basis Report, p.6).

Cost calculations for the baseline remedy are based on cost information provided in the December 2010 Draft FFS (in which the barrier wall remedy was identified as "Alternative B: Containment Wall"), since no updated costs were included in the constructability work plan. The capital cost for this alternative was based on the constructability work plan, which indicated that cost for the cement bentonite slurry wall may be up to two times that of the soil bentonite slurry wall. The annual maintenance costs are assumed to be the same for all alternatives. A summary cost sheet developed by the GSR Team is included in Appendix C1. Information regarding the cost calculations is as follows:

- The capital cost is $2,420,584 (twice that of the baseline alternative) and occurs in year 0.

- The annual operating cost is $5,000, occurring each year in years 1 through 100.

- The sum of capital and annual costs, non-discounted, is $2,920,584.

- To determine net present value (NPV), a 2.7 percent discount rate is applied to future costs, which is consistent with the discount rate applied in the Draft FFS. NPV is calculated by discounting future costs to present-day dollars using the following equation:

$$PV = \frac{FV}{(1+i)^n} = C \times FV$$

PV is the present value
FV is the value in year "n" (i.e., future value)
i is the discount rate
C is the discount factor, which equals $1/(1+i)^n$

- The NPV calculated by the GSR Team is $2,592,870.

2.3.2 Summary of Quantitative Footprint Results for Alternative 1 versus Baseline

Table 2-3 summarizes the footprint results for Alternative 1 compared to the results for the Baseline. Input to the SiteWise tool and other supporting calculations for Alternative 1 are described in Appendix C1. A cost spreadsheet is also included in Appendix C1.

Table 2-3
Summary of Quantitative Footprint for SB Slurry Wall (Baseline) versus CB Slurry Wall (Alternative 1)

GSR Parameter	Unit	SB Slurry Wall Value (Baseline)	CB Slurry Wall Value (Alternative 1)
Environmental			
Energy – Total	MMBtu	5,905	11,636
Energy – Direct Scope 1	MMBtu	2,032	2,032
Energy – Indirect Scope 2	MMBtu	0	0
Energy – Indirect Scope 3	MMBtu	3,873	9,604
% of Energy from Renewable Resources	%	0%	0%
Global warming potential – Total	Metric tons CO2e	452	1,651
Global warming potential – Direct Scope 1	Metric tons CO2e	185	185
Global warming potential – Indirect Scope 2	Metric tons CO2e	0	0
Global warming potential – Indirect Scope 3	Metric tons CO2e	267	1,466
Criteria air pollutant emissions	Metric tons (NOx+SOx+PM)	1.84	1.84
Hazardous air pollutant emissions	Lb	0	0
Potable water use	1,000s of gallons	3,500	3,500
Other water use	1,000s of gallons	Negligible	Negligible
Refined materials use	Lbs	3,428	3,296,488
% of refined materials from recycled material	%	0	0
Unrefined materials use	Ton	6,533	4,510
% of unrefined materials from recycled material	%	0	0
Non-hazardous waste generation	Ton	0	0
Hazardous waste generation	Ton	0	0
% of potential waste that is recycled or re-used	%	Not determined	Not determined
Land transferred or made available for beneficial use	Acres	0	0

GSR Parameter	Unit	SB Slurry Wall Value (Baseline)	CB Slurry Wall Value (Alternative 1)
Economic			
Life-cycle Cost, Discounted (2.7% discount rate)	$	$1.4 M*	$2.6 M*
Life-cycle Cost, Undiscounted	$	$1.7 M*	$2.9 M*
Up-front Cost	$	$1.2 M*	$2.4 M*
Societal			
Predicted number of injuries or fatalities for On-Site Worker	Number of injuries or fatalities	0.003	0.003
Predicted number of injuries or fatalities associated with transportation	Number of injuries or fatalities	0.02	0.02
One-Way Heavy Vehicle Trips through Res. Area	Trips	None	None

** Based on cost info in December 2010 Draft FFS (no updated costs with constructability work plan). For Alternative 1, the constructability work plan indicates that costs may be up to twice those for the baseline.*

2.3.3 Primary Footprints That Would Improve for Alternative 1

Most of the footprints do not improve for Alternative 1 versus the baseline. The unrefined material use decreases by 2,023 tons (~31% decrease), but that is simply the result of a tradeoff to more refined materials, which is not a positive with respect to GSR considerations.

2.3.4 Primary Footprints That Would Worsen for Alternative 1

The following key footprints would worsen in this variation versus the baseline:

- Energy use increases by 5,731 MMBTU (~97% increase), due to the energy use associated with production of the cement used for the CB slurry wall.
- Global warming potential increases by 1,199 metric tons of CO_2e (~265% increase) due to the production of the cement used for the CB slurry wall.
- Criteria air pollutant emissions remain the same because SiteWise does not calculate these emissions for materials production. It is assumed that since this Alternative involves a significant increase in refined materials usage, criteria air pollutant emissions would increase.
- Refined material use increases by 3,293,060 tons (~96,064% increase) due to the cement used for the CB slurry wall.
- Discounted life-cycle costs increase by $1.2M, based on cost increase estimated by Project Team.

2.4 QUANTITATIVE FOOTPRINT ANALYSIS FOR ALTERNATIVE 2 – GROUTED SHEET PILE WALL

2.4.1 Overview of Alternative 2

This alternative utilizes a grouted sheet pile (steel) barrier wall rather than a SB barrier wall (baseline). For the purposes of footprinting, this alternative is assumed to involve the following components:

- A pre-construction constructability investigation
- Grouted sheet pile barrier wall construction
- Barrier wall O&M (minimal cost of $5,000 per year estimated in the FS, no other specific footprints for O&M were calculated)

Note that the *Draft Constructability Basis Report* contains fewer details regarding the construction of the grouted sheet pile wall versus the more detailed information provided for the soil bentonite slurry wall. The GSR Team estimated steel usage as 566 tons of sheet pile (estimated from using default "section" AZ 12-770 and entering approximate length of 300 m and height of 20 m) based on the following website: http://www.arcelorprojects.nl/EN/calculation1.htm.

Cost calculations for the baseline remedy are based on cost information provided in the December 2010 Draft FFS (in which the barrier wall remedy was identified as "Alternative B: Containment Wall"), since no updated costs were included in the constructability work plan. The capital cost for this alternative was based on the constructability work plan, which indicated that cost for the grouted sheet pile wall may be three to four times that of the soil bentonite slurry wall. The annual maintenance costs are assumed to be the same for all alternatives. A summary cost sheet developed by the GSR Team is attached to Appendix C2. Information regarding the cost calculations is as follows:

- The capital cost is $3,630,876 (3 times that of the baseline alternative) and occurs in year 0.
- The annual operating cost is $5,000, occurring each year in years 1 through 100.
- The sum of capital and annual costs, non-discounted, is $4,130,876.
- To determine net present value (NPV), a 2.7 percent discount rate is applied to future costs, which is consistent with the discount rate applied in the Draft FFS. NPV is calculated by discounting future costs to present-day dollars using the following equation:

$$PV = \frac{FV}{(1+i)^n} = C \times FV$$

PV is the present value
FV is the value in year "n" (i.e., future value)
i is the discount rate
C is the discount factor, which equals $1/(1+i)^n$

- The NPV calculated by the GSR Team is $3,803,162.

2.4.2 Summary of Quantitative Footprint Results for Alternative 2 versus Baseline

Table 2-4 summarizes the footprint results for Alternative 2 compared to the results for the Baseline. Input to the SiteWise tool and other supporting calculations for Alternative 2 are described in Appendix C2.

Table 2-4
Summary of Quantitative Footprint for SB Slurry Wall (Baseline) versus Grouted Sheet Pile Wall (Alternative 2)

GSR Parameter	Unit	SB Slurry Wall Value (Baseline)	Sheet Pile Wall Value (Alternative 2)
Environmental			
Energy – Total	MMBtu	5,905	17,456
Energy – Direct Scope 1	MMBtu	2,032	220
Energy – Indirect Scope 2	MMBtu	0	0
Energy – Indirect Scope 3	MMBtu	3,873	17,237
% of Energy from Renewable Resources	%	0%	0%
Global warming potential – Total	Metric tons CO2e	452	1448
Global warming potential – Direct Scope 1	Metric tons CO2e	185	19
Global warming potential – Indirect Scope 2	Metric tons CO2e	0	0
Global warming potential – Indirect Scope 3	Metric tons CO2e	267	1,429
Criteria air pollutant emissions	Metric tons (NOx+SOx+PM)	1.84	0.24
Hazardous air pollutant emissions	Lb	0	0
Potable water use	1,000s of gallons	3,500	0
Other water use	1,000s of gallons	Negligible	Negligible
Refined materials use	Lbs	3,428	1,135,428
% of refined materials from recycled material	%	0	0
Unrefined materials use	Ton	6,533	432
% of unrefined materials from recycled material	%	0	0
Non-hazardous waste generation	Ton	0	0
Hazardous waste generation	Ton	0	0
% of potential waste that is recycled or re-used	%	Not determined	Not determined
Land transferred or made available for beneficial use	Acres	0	0
Economic			
Life-cycle Cost, Discounted (2.7% discount rate)	$	$1.4 M*	$3.8 M*
Life-cycle Cost, Undiscounted	$	$1.7 M*	$4.1 M*
Up-front Cost	$	$1.2 M*	$3.6 M*
Societal			
Predicted number of injuries or fatalities for On-Site Worker	Number of injuries or fatalities	0.003	0.003
Predicted number of injuries or fatalities associated with transportation	Number of injuries or fatalities	0.02	0.02
One-Way Heavy Vehicle Trips through Res. Area	Trips	None	None

** Based on cost info in December 2010 Draft FFS (no updated costs with constructability work plan). For Alternative 2, the constructability work plan indicates that costs may be up to three to four times those for the baseline.*

2.4.3 Primary Footprints That Would Improve for Alternative 2

The following key footprints would improve in this alternative versus the baseline:

- The criteria air pollutants decrease by 1.6 metric tons (~87% decrease) due to decreased on-site equipment usage. It should be noted that this decrease may be due in part to the fact that criteria air pollutant emissions for materials production are not calculated by SiteWise. It is assumed that since this Alternative involves a significant increase in refined materials usage (particularly steel), criteria air pollutant emissions would increase at the location where the steel is produced.

- Use of 3.5 million gallons of potable water (for mixing the slurry wall) is eliminated.

- Unrefined material use decreases by 6,101 tons (~93% decrease). However, that is simply the result of a tradeoff to more refined materials, which is not a positive with respect to GSR considerations.

2.4.4 Primary Footprints That Would Worsen for Alternative 2

The following key footprints would worsen in this variation versus the baseline:

- Energy use increases by 11,551 MMBTU (~196% increase) due to the energy use associated with production of the steel used for the sheet pile wall.

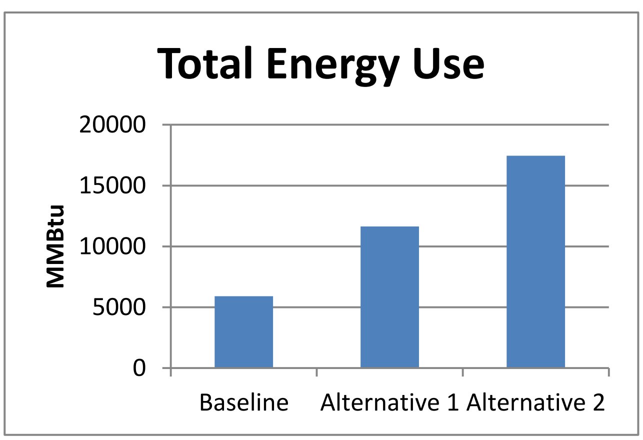
- Global warming potential increases by 996 metric tons of CO2e (~220% increase) due to the production of the steel used for the sheet pile wall.

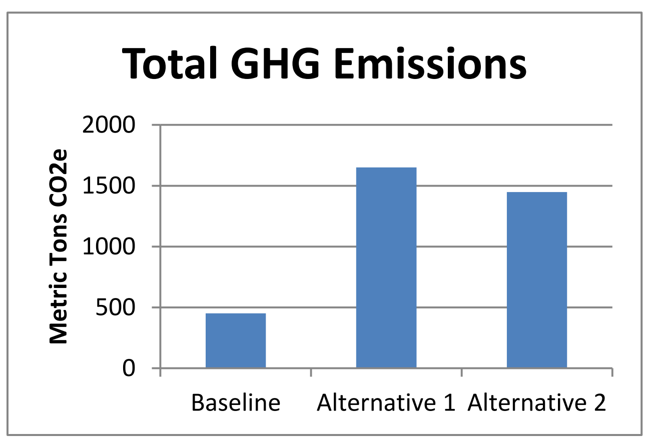
- Refined material use increases by 1,132,000 tons (~33,022% increase) due to the steel used for the sheet pile wall.

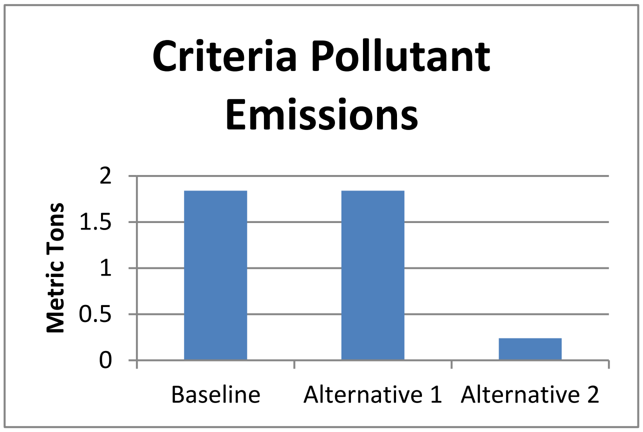
- Discounted life-cycle costs increase by $2.4M, based on cost increase estimated by Project Team.

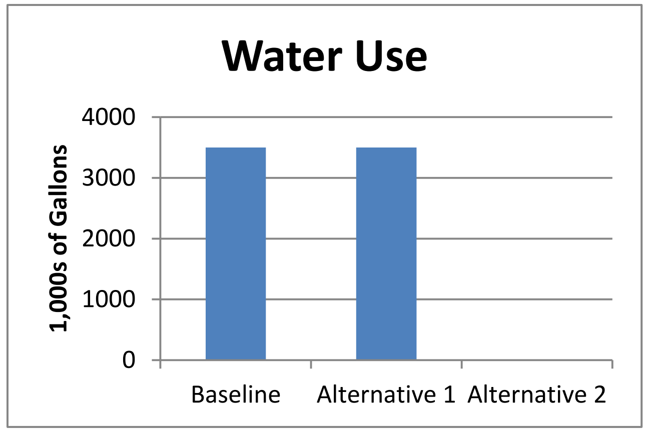
2.5 COMPARISON OF KEY FOOTPRINTS FOR BASELINE VERSUS ALTERNATIVES

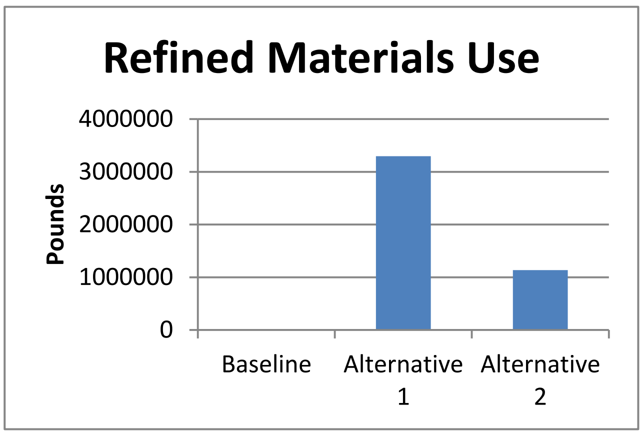
The charts below illustrate the values for some of the key footprints calculated for the soil bentonite slurry wall (baseline) versus Alternative 1 (cement bentonite slurry wall) and Alternative 2 (grouted sheet pile wall).

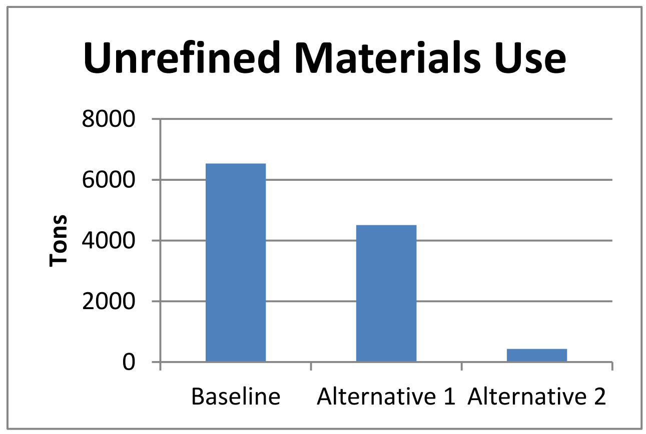


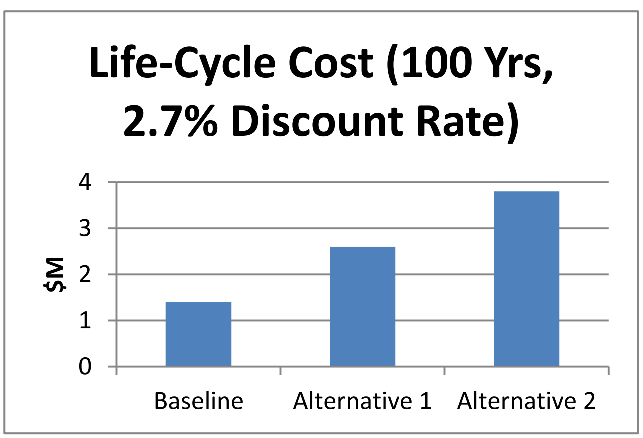


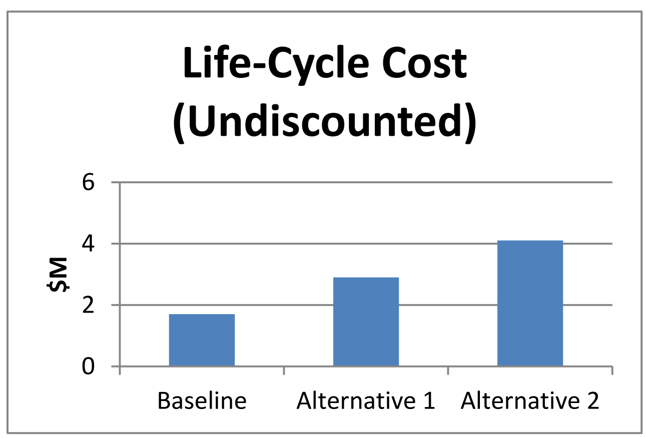

Criteria Pollutant Emissions
Metric Tons
2
1.5
1
0.5
0
Baseline
Alternative 1
Alternative 2

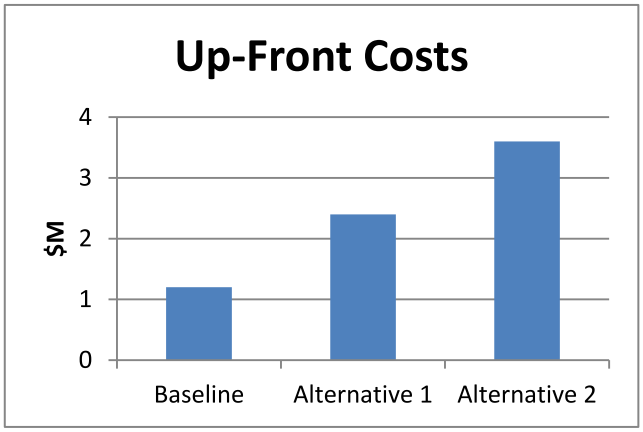

Water Use
1,000s of Gallons
4000
3000
2000
1000
0
Baseline
Alternative 1
Alternative 2


Refined Materials Use
Pounds
4000000
3000000
2000000
1000000
0
Baseline
Alternative 1
Alternative 2


Unrefined Materials Use
Tons
8000
6000
4000
2000
0
Baseline
Alternative 1
Alternative 2


Life-Cycle Cost (100 Yrs, 2.7% Discount Rate)
$M
4
3
2
1
0
Baseline
Alternative 1
Alternative 2


Life-Cycle Cost (Undiscounted)
$M
6
4
2
0
Baseline
Alternative 1
Alternative 2



Most of the footprints (including life-cycle cost, up-front cost, energy use, greenhouse gas emissions, and refined materials usage) are lowest for the baseline alternative. Some of the footprints (criteria pollutant emissions and water use) are lower for Alternative 2, but those specific footprint reductions would not be expected to justify the increases in other footprints (including cost) for Alternative 2. Although unrefined materials usage is highest for the baseline alternative, Alternatives 1 and 2 have lower unrefined materials use at the expense of additional refined materials use. Overall, the GSR footprint comparison supports the selection of the baseline alternative consistent with the Project Team's preliminary constructability evaluation.

2.6 COMPARISON OF FOOTPRINTING BETWEEN DRAFT FFS PHASE AND CONSTRUCTABILITY PHASE

As previously mentioned, a GSR evaluation was conducted for the Shepley's Hill Landfill site during an earlier remedy phase (based on the December 2010 Draft FFS). The previous GSR evaluation included quantitative footprinting of a potential soil-bentonite barrier wall between the closed landfill and Plow Shop Pond, based on Draft FFS-level data. That previous evaluation was conducted with SiteWise Version 1.0 (SiteWise has since been updated, and Version 2.0 was utilized for the quantitative analysis for the Constructability Phase GSR evaluation presented in this report). A comparison of key metrics calculated in the Draft FFS phase evaluation versus those calculated for the baseline scenario in this Constructability Phase evaluation (both for soil-bentonite slurry walls) is presented in Table 2-5 below.

Table 2-5
Summary of Quantitative Footprint for Barrier Wall in the Draft FFS Phase versus Constructability Phase

GSR Parameter	Unit	Draft FFS Phase*	Constructability Phase (Baseline Scenario)
Energy Use	MMBtu	1,816	5,905
Global Warming Potential	Metric tons CO2e	109	452
Potable Water Use	1,000s of gallons	Negligible	3,500
Refined Materials Use	Lbs	0	3,428
Unrefined Materials Use	Tons	6,597	6,533

**Refers to Alternative B (soil-bentonite slurry wall) in the December 2010 Draft FFS*

Observations regarding the changes in the quantitative footprints calculated during the Draft FFS Phase versus the Constructability Phase include the following:

- The increases in energy use and global warming potential in the Constructability Phase evaluation versus the Draft FFS-Phase evaluation are mainly caused by:

    - Increases in estimated equipment use (the Draft FFS Phase evaluation assumed that a single excavator would be used for barrier wall construction and SiteWise calculated fuel use, whereas the Constructability Phase information provided a much higher estimated fuel use of 500 gallons of diesel per day); and

    - Increases in energy for production of materials (the Constructability Phase evaluation included more material, partially because more detail was provided in pre-construction documents and partially because the updated version of SiteWise has additional options for materials input that were not available at the time of the first evaluation such as bentonite).

- The increase in water use in the Pre-Construction Phase evaluation is due to the fact that water required for the slurry mix was not accounted for in the Draft FFS Phase evaluation.

- The increase in refined materials in the Pre-Construction Phase use is due to the inclusion of anticipated materials needed for well installation during the pre-construction investigation (not accounted for in the Draft FFS Phase evaluation), and landfill cap extension over the slurry wall (not accounted for in the Draft FFS Phase evaluation).

- The quantity of unrefined materials use remains approximately the same.

Overall, the calculated footprint for this part of the likely future remedy increased between the Draft FFS Phase and the Constructability Phase. This increase is due in large part to the greater level of detail regarding the remedy construction available to the GSR Team at this later phase of the remedy. Note the increase in footprints is not believed to be a general result, because in other cases the additional information available during the Constructability Phase could cause the calculated footprints to decline versus an earlier FFS phase. Also note that the footprints calculated in the Draft FFS Phase compared a soil-bentonite slurry wall (Alternative B) versus a permeable reactive barrier wall (Alternative A), and the footprints were lower for Alternative B. Even with the higher footprints for the soil barrier wall computed in the Constructability Phase, those footprints are still lower than for Alternative A in the Draft FFS.

In addition, changes to the SiteWise tool between the FFS Phase and the Constructability Phase evaluations also played a minor role in the revised footprint calculation results. Some of these changes to SiteWise included the following:

- Additional options for materials input (particularly for bentonite, a material for which SiteWise Version 1 did not have data)

- Updated conversion factors that take into account upstream emissions

- Increased fuel efficiency for vehicles

Based on a comparison of two versions of the software, the changes caused by the differences between SiteWise Version 1 and Version 2 are considered to be minimal compared to the changes in footprints resulting from the greater level of detail for the input data provided during the Constructability Phase.

2.7 OTHER QUALITATIVE CONSIDERATIONS

None.

3.0 GSR RECOMMENDATIONS

These are recommendations provided by the GSR Team for the consideration of the Project Team, and potentially other project stakeholders. These are not requirements, and implementation should ultimately be decided by the Project Team based on their concurrence regarding GSR benefits and/or other project-specific constraints.

Overall, the GSR Team concurs with the Project Team's preliminary conclusion that the soil bentonite slurry wall appears to be a better choice than the other two barrier alternatives. This is due to lower costs, as well as lower footprints for most of the other footprints considered. These recommendations therefore pertain to the SB slurry wall since that is the likely final choice.

The GSR team offers no recommendations based on quantitative footprints. However, based on a preliminary review of the BMPs in Appendix A, the GSR Team has several recommendations for the Project Team to consider (from a GSR perspective) as the constructability of the barrier wall proceeds from the current preliminary stage of the design to a more advance stage of the design. These GSR recommendations are summarized in the form of tracking tables, as follows:

Table Number	Recommendation
3-1	3.1 - Include a GSR section in constructability plan summarizing GSR considerations that were incorporated into the barrier wall design.
3-2	3.2 - Indicate in the constructability plan if there are specific scheduling considerations or constraints (e.g., seasons) that should be taken into account to avoid construction delays and/or maximize construction efficiency.
3-3	3.3 - In the constructability plan indicate the most likely location for obtaining materials and equipment, and indicate if they are being obtained from the closest feasible locations.
3-4	3.4 - Evaluate in more detail the feasibility for using water from Plow Shop Pond or P&T system effluent rather than potable water from a fire hydrant.
3-5	*3.5* - Indicate in the constructability plan what chemicals will be used for cleaning equipment, and document that the selection of chemicals was based on consideration of lowest toxicity to site workers and/or habitat (e.g., runoff to Plow Shop Pond).
3-6	3.6 - Indicate in the constructability plan what soil erosion control measures will be implemented to protect Plow Shop Pond.
3-7	3.7 - Indicate in the constructability plan that potential constraints to construction with respect to potential disturbances to the surrounding community (e.g., noise, light, odor, visual) have been considered (and addressed if any are identified).
3-8	3.8 - Indicate in constructability plan any clauses that might be included in the construction contract to promote GSR considerations (e.g., to avoid excessive idling of equipment).

The tracking table format allows the implementation status of the recommendation to be updated as the project progresses.

Table 3-1
Tracking Table for Recommendation 3.1

Recommendation: *3.1 - Include a GSR section in constructability plan summarizing GSR considerations that were incorporated into the barrier wall design.*	Current Date: 4/10/12 Date of Original Recommendation: 4/10/12
Basis for Recommendation (Include discussion of cost impacts and value if appropriate): *Addresses a BMP to include a GSR section in site reports. Demonstrates to stakeholders that GSR issues are being considered and addressed within the design.*	
Resources Conserved: ☐ Hazardous air pollutants ☐ GHG emissions (CO2e) ☐ Energy ☐ Water ☐ Waste ☐ Criteria pollutants ☐ Safety/Community ☐ Materials ☐ Land-use	
Qualitative Net Cost Impact Over 5 Years, No Discounting ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A	☐ Recommended action otherwise required? If checked, required by:
Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000	
Attachment(s) to report with footprint assumptions and calculations: *This is a qualitative recommendation, and no footprint evaluation was performed regarding this recommendation.*	
Implementation Status: ☐ Fully ☐ Partially ☒ Not Yet ☐ Not Planned	Explanation of Status: *This is a new recommendation for consideration of the Project Team as the constructability progresses from the current preliminary constructability towards the final constructability plan.*

Table 3-2
Tracking Table for Recommendation 3.2

<table>
<tr><td colspan="2">Recommendation:

3.2 - Indicate in the constructability plan if there are specific scheduling considerations or constraints (e.g., seasons) that should be taken into account to avoid construction delays and/or maximize construction efficiency.</td><td>Current Date:
4/10/12
Date of Original Recommendation:
4/10/12</td></tr>
<tr><td colspan="3">Basis for Recommendation (Include discussion of cost impacts and value if appropriate):

So that the constructability plan addresses if certain times of year should be avoided with respect to construction, so that equipment use is minimized.</td></tr>
<tr><td colspan="3">Resources Conserved:
☐ Hazardous air pollutants ☒ GHG emissions (CO2e) ☒ Energy ☐ Water ☐ Waste
☒ Criteria pollutants ☐ Safety/Community ☐ Materials ☐ Land-use</td></tr>
<tr><td colspan="2">Qualitative Net Cost Impact Over 5 Years, No Discounting

☐ Cost Increase ☐ Cost Savings
☒ Cost Neutral ☐ N/A</td><td>☐ Recommended action otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="3">Attachment(s) to report with footprint assumptions and calculations:

This is a qualitative recommendation, and no footprint evaluation was performed regarding this recommendation.</td></tr>
<tr><td>Implementation Status:

☐ Fully
☐ Partially
☒ Not Yet
☐ Not Planned</td><td colspan="2">Explanation of Status:

This is a new recommendation for consideration of the Project Team as the constructability progresses from the current preliminary constructability plan towards the final constructability plan.</td></tr>
</table>

Table 3-3
Tracking Table for Recommendation 3.3

<table>
<tr><td colspan="2">Recommendation:

3.3 - In the constructability plan, indicate the most likely location for obtaining materials and equipment, and indicate if they are being obtained from the closest feasible locations.</td><td>Current Date:
4/10/12
Date of Original Recommendation:
4/10/12</td></tr>
<tr><td colspan="3">Basis for Recommendation (Include discussion of cost impacts and value if appropriate):

So the constructability plan indicates that the GSR consideration to minimize trip lengths was addressed, as well as the GSR consideration to utilize resources from the local community when possible.</td></tr>
<tr><td colspan="3">Resources Conserved:
☐ Hazardous air pollutants ☒ GHG emissions (CO2e) ☒ Energy ☐ Water ☐ Waste
☒ Criteria pollutants ☒ Safety/Community ☐ Materials ☐ Land-use</td></tr>
<tr><td>Qualitative Net Cost Impact Over 5 Years, No Discounting
☐ Cost Increase ☐ Cost Savings
☒ Cost Neutral ☐ N/A</td><td colspan="2">☐ Recommended action otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="3">Attachment(s) to report with footprint assumptions and calculations:

This is a qualitative recommendation, and no footprint evaluation was performed regarding this recommendation.</td></tr>
<tr><td>Implementation Status:

☐ Fully
☐ Partially
☒ Not Yet
☐ Not Planned</td><td colspan="2">Explanation of Status:

This is a new recommendation for consideration of the Project Team as the constructability progresses from the current preliminary constructability plan towards the final constructability plan.</td></tr>
</table>

Table 3-4
Tracking Table for Recommendation 3.4

<table>
<tr><td colspan="2" rowspan="2">Recommendation:

3.4 - Evaluate in more detail the feasibility for using water from Plow Shop Pond or P&T system effluent rather than potable water from a fire hydrant.</td><td>Current Date:
4/10/12</td></tr>
<tr><td>Date of Original Recommendation:
4/10/12</td></tr>
<tr><td colspan="3">Basis for Recommendation (Include discussion of cost impacts and value if appropriate):

To use less refined water resources in place of potable water if technically feasible and not cost prohibitive. It is assumed this would be cost-neutral, and this should not be pursued if it will significantly increase costs.</td></tr>
<tr><td colspan="3">Resources Conserved:
☐ Hazardous air pollutants ☐ GHG emissions (CO2e) ☐ Energy ☒ Water ☐ Waste
☐ Criteria pollutants ☐ Safety/Community ☐ Materials ☐ Land-use</td></tr>
<tr><td>Qualitative Net Cost Impact Over 5 Years, No Discounting

☐ Cost Increase ☐ Cost Savings
☒ Cost Neutral ☐ N/A</td><td colspan="2">☐ Recommended action otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="3">Attachment(s) to report with footprint assumptions and calculations:

This is a qualitative recommendation, and no footprint evaluation was performed regarding this recommendation.</td></tr>
<tr><td>Implementation Status:

☐ Fully
☐ Partially
☒ Not Yet
☐ Not Planned</td><td colspan="2">Explanation of Status:

This is a new recommendation for consideration of the Project Team as the constructability progresses from the current preliminary constructability plan towards the final constructability plan.</td></tr>
</table>

Table 3-5
Tracking Table for Recommendation 3.5

<table>
<tr><td colspan="2">Recommendation:

3.5 - Indicate in the constructability plan what chemicals will be used for cleaning equipment, and document that the selection of chemicals was based on consideration of lowest toxicity to site workers and/or habitat (e.g., runoff to Plow Shop Pond).</td><td>Current Date:
4/10/12

Date of Original Recommendation:
4/10/12</td></tr>
<tr><td colspan="3">Basis for Recommendation (Include discussion of cost impacts and value if appropriate):

To document that chemicals are being chosen with consideration of toxicity or negative impacts to humans and the environment.</td></tr>
<tr><td colspan="3">Resources Conserved:
☐ Hazardous air pollutants ☐ GHG emissions (CO2e) ☐ Energy ☐ Water ☐ Waste
☐ Criteria pollutants ☒ Safety/Community ☐ Materials ☐ Land-use</td></tr>
<tr><td>Qualitative Net Cost Impact Over 5 Years, No Discounting

☐ Cost Increase ☐ Cost Savings
☒ Cost Neutral ☐ N/A</td><td colspan="2">☐ Recommended action otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="3">Attachment(s) to report with footprint assumptions and calculations:

This is a qualitative recommendation, and no footprint evaluation was performed regarding this recommendation.</td></tr>
<tr><td>Implementation Status:

☐ Fully
☐ Partially
☒ Not Yet
☐ Not Planned</td><td colspan="2">Explanation of Status:

This is a new recommendation for consideration of the Project Team as the constructability progresses from the current preliminary constructability plan towards the final constructability plan.</td></tr>
</table>

Table 3-6
Tracking Table for Recommendation 3.6

<table>
<tr><td colspan="2">Recommendation:

3.6 - Indicate in the constructability plan what soil erosion control measures will be implemented to protect Plow Shop Pond.</td><td>Current Date:
4/10/12
Date of Original Recommendation:
4/10/12</td></tr>
<tr><td colspan="3">Basis for Recommendation (Include discussion of cost impacts and value if appropriate):

Generally part of any constructability plan, was not included in the preliminary constructability plan.</td></tr>
<tr><td colspan="3">Resources Conserved:
☐ Hazardous air pollutants ☐ GHG emissions (CO2e) ☐ Energy ☐ Water ☐ Waste
☐ Criteria pollutants ☒ Safety/Community ☐ Materials ☐ Land-use</td></tr>
<tr><td>Qualitative Net Cost Impact Over 5 Years, No Discounting

☐ Cost Increase ☐ Cost Savings
☒ Cost Neutral ☐ N/A</td><td colspan="2">☐ Recommended action otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="3">Attachment(s) to report with footprint assumptions and calculations:

This is a qualitative recommendation, and no footprint evaluation was performed regarding this recommendation.</td></tr>
<tr><td>Implementation Status:

☐ Fully
☐ Partially
☒ Not Yet
☐ Not Planned</td><td colspan="2">Explanation of Status:

This is a new recommendation for consideration of the Project Team as the constructability progresses from the current constructability plan towards the final constructability plan.</td></tr>
</table>

Table 3-7
Tracking Table for Recommendation 3.7

<table>
<tr><td colspan="3" rowspan="2">Recommendation:

3.7 - Indicate in the constructability plan that potential constraints to construction with respect to potential disturbances to the surrounding community (e.g., noise, light, odor, visual) have been considered (and addressed if any are identified).</td><td>Current Date:
4/10/12</td></tr>
<tr><td>Date of Original Recommendation:
4/10/12</td></tr>
<tr><td colspan="4">Basis for Recommendation (Include discussion of cost impacts and value if appropriate):

So the constructability plan indicates that the GSR consideration to minimize such impacts to the community have been considered and addressed.</td></tr>
<tr><td colspan="4">Resources Conserved:
☐ Hazardous air pollutants ☐ GHG emissions (CO2e) ☐ Energy ☐ Water ☐ Waste
☐ Criteria pollutants ☒ Safety/Community ☐ Materials ☐ Land-use</td></tr>
<tr><td colspan="2">Qualitative Net Cost Impact Over 5 Years, No Discounting

☐ Cost Increase ☐ Cost Savings
☒ Cost Neutral ☐ N/A</td><td colspan="2">☐ Recommended action otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="4">Attachment(s) to report with footprint assumptions and calculations:

This is a qualitative recommendation, and no footprint evaluation was performed regarding this recommendation.</td></tr>
<tr><td>Implementation Status:

☐ Fully
☐ Partially
☒ Not Yet
☐ Not Planned</td><td colspan="3">Explanation of Status:

This is a new recommendation for consideration of the Project Team as the constructability progresses from the current preliminary constructability plan towards the final constructability plan.</td></tr>
</table>

Table 3-8
Tracking Table for Recommendation 3.8

<table>
<tr><td colspan="2" rowspan="2">Recommendation:

3.8 - Indicate in final constructability plan any clauses that might be included in the construction contract to promote GSR considerations (e.g., to avoid excessive idling of equipment).</td><td>Current Date:
4/10/12</td></tr>
<tr><td>Date of Original Recommendation:
4/10/12</td></tr>
<tr><td colspan="3">Basis for Recommendation (Include discussion of cost impacts and value if appropriate):

So resulting construction contract(s) can ensure that specific GSR items identified in the constructability plan will be implemented by the construction contractor. Only items that are cost neutral or result in cost savings should be included, unless the item addresses a significant concern of one or more stakeholders.</td></tr>
<tr><td colspan="3">Resources Conserved:
☐ Hazardous air pollutants ☒ GHG emissions (CO2e) ☐ Energy ☐ Water ☐ Waste
☐ Criteria pollutants ☐ Safety/Community ☐ Materials ☐ Land-use</td></tr>
<tr><td>Qualitative Net Cost Impact Over 5 Years, No Discounting

☐ Cost Increase ☐ Cost Savings
☒ Cost Neutral ☐ N/A</td><td colspan="2">☐ Recommended action otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="3">Attachment(s) to report with footprint assumptions and calculations:

This is a qualitative recommendation, and no footprint evaluation was performed regarding this recommendation.</td></tr>
<tr><td>Implementation Status:

☐ Fully
☐ Partially
☒ Not Yet
☐ Not Planned</td><td colspan="2">Explanation of Status:

This is a new recommendation for consideration of the Project Team as the constructability progresses from the current preliminary constructability plan towards the final constructability plan.</td></tr>
</table>

FIGURES

From "*Draft Constructability Basis Report, Hydraulic Barrier Wall at Shepley's Hill Landfill*" (AMEC, 21 October 2011)

SITE LOCATION

Shepley's Hill Landfill Area
Proposed Barrier Wall Alignment

Devens
Ayer, Massachusetts

Notes & Sources: Aerial Imagery: 1:5,000 Color Digital Ortho Images, Mass GIS, 2005.

LEGEND

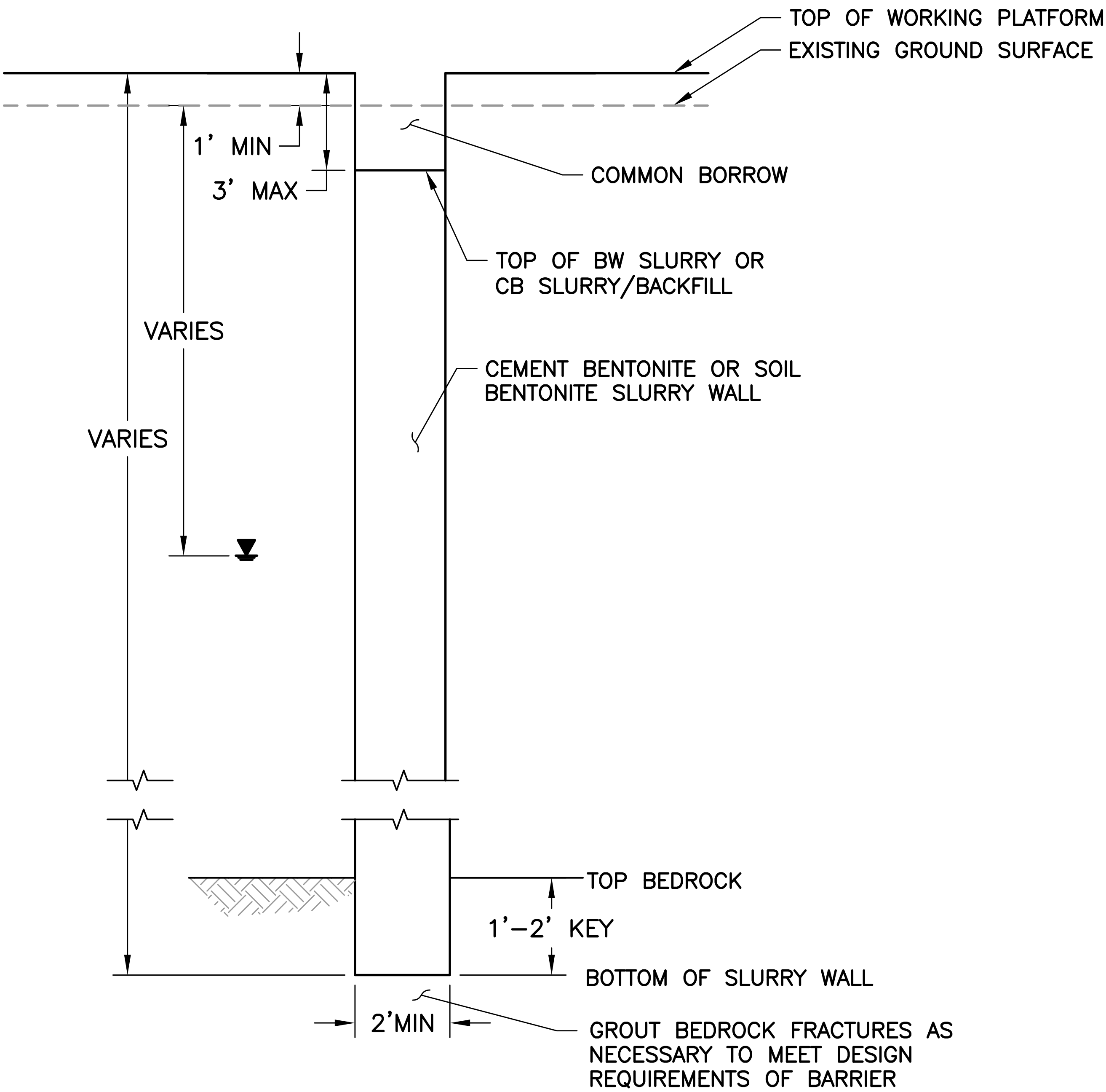
Streams
Topographic Elevation Contour (ft)
Shepley Parcel
Landfill Boundary
Proposed Barrier Wall

0 200
Approximate Scale in Feet

amec
AMEC Earth & Environmental, Inc.
2 Robbins Road
Westford, MA 01886
(978) 692-9090

FIGURE
1

H:\ShepleyLandfill\Task17\MXD\Figure6-1.mxd H:\ShepleyLandfill\Task17\Export\Figure6-1.pdf December 2, 2008 DWN: APC DJK CHKD: KMP



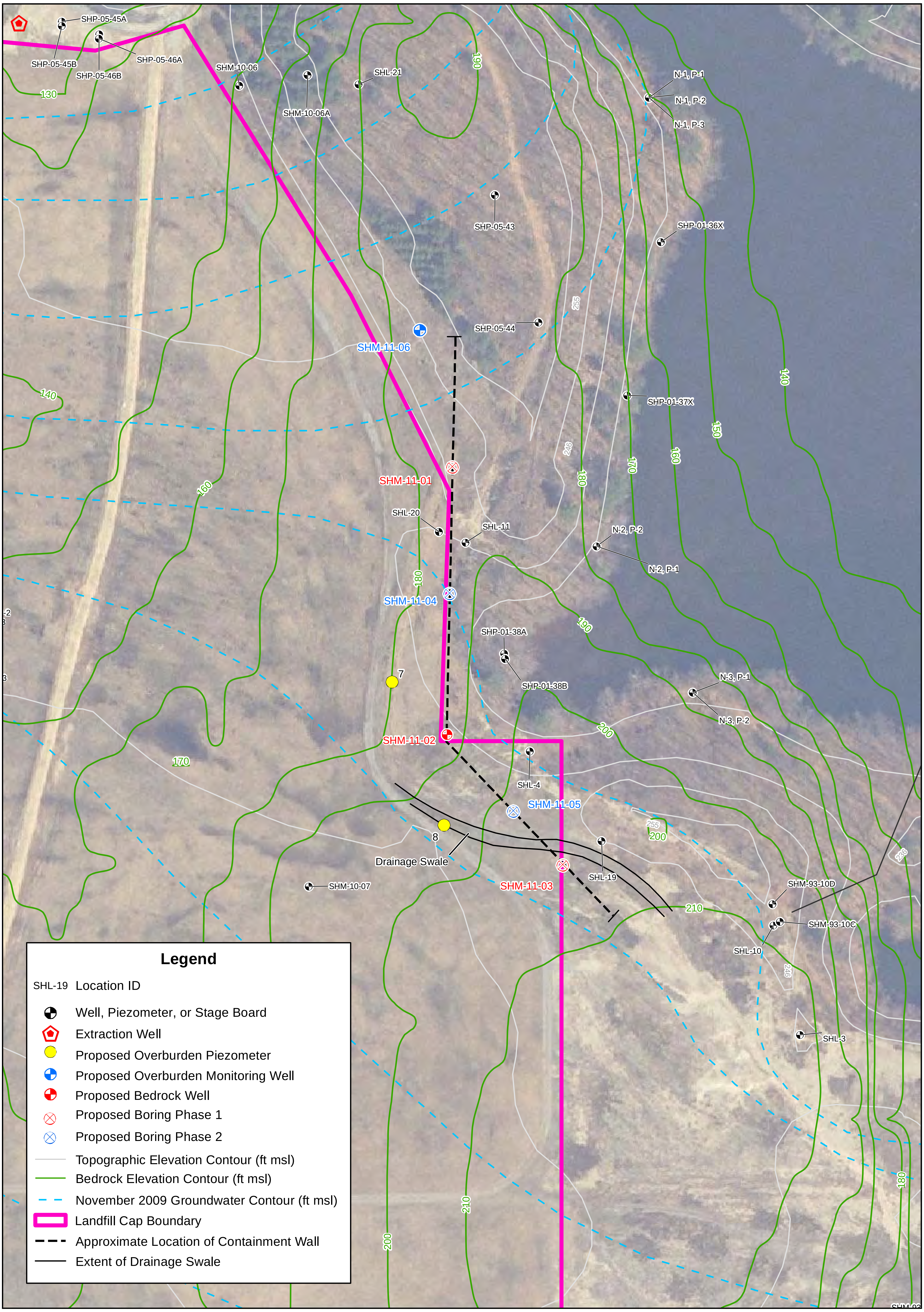
SLURRY WALL TYPICAL SECTION

NOT TO SCALE

Prepared/Date: RHH 10/17/11
Checked/Date: RSE 10/17/11

BARRIER WALL DETAIL SHEPLEY HILL LANDFILL AYER,MA	amec	SLURRY WALL PROFILE Project 3617-11-7248 Figure 2

M:\Projects\Devens SHL Slurry Wall–Sovereign Consulting Inc\FIGURE–SLURRY–WALL–DETAIL.dwg Tue, 18 Oct 2011 – 3:07pm rhholman



Location of Site

Pre-construction Investigation for Proposed Containment Wall

Shepley's Hill Landfill
Ayer, Massachusetts

N

0 115
Feet

FIGURE
3

amec

H:\ShepleyLandfill\Task42\MXD\Fig2_PredesignInvestigationforProposedContainmentWall.mxd October 14, 2011 DWN: jonathan.penney CHKD: AKN

Aerial Imagery: 1:5,000 Color Digital Ortho Images, Mass GIS, 2005.

APPENDIX A

Best Management Practice (BMP) Tables

BMP Category A: Planning

BMP A-1: Develop a culture of GSR within the Project Team and encourage GSR ideas from project staff	**Date:** 4/10/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☒ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

It has been indicated in Draft Constructability Basis Report that "Barrier wall materials and installation methods will employ sustainability measures to reduce waste and carbon footprints".

BMP A-2: Incorporate a section on GSR in project meetings, work plans, and reports	**Date:** 4/10/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☒ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

The Draft Constructability Basis Report indicated that the concept of sustainability will be a considered in the selection of the final remedy. It is recommended that the constructability plan include a specific section discussing specific sustainability considerations.

BMP Category A: Planning

BMP A-3: Identify and periodically update a list of key stakeholders and their concerns with respect to GSR considerations	**Date:** 4/10/12 ☒ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

This general BMP is potentially applicable for the barrier wall constructability to determine if there are any stakeholder concerns regarding any of the construction activities or use of specific materials, but such concerns are expected to be very minor for this limited remedial activity (barrier wall) and were not specifically evaluated.

BMP A-4: Schedule activities for appropriate seasons and/or time of day to reduce delays caused by weather conditions and fuel needed for heating or cooling Examples: - Work at night in summer to avoid heat stress - Perform field activities in summer to take advantage of longer daylight	**Date:** 4/10/12 ☒ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

This BMP is potentially applicable, but is not addressed in the Draft Constructability Basis Report. It is recommended that the more detailed design (that will be performed after the pre-construction investigation) identify if there are specific scheduling considerations or constraints that should be taken into account to avoid construction delays and/or maximize construction efficiency.

BMP Category A: Planning

BMP A-5: Prepare, store, and distribute documents electronically	**Date:** 4/10/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☒ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☐ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Site documents have been delivered to the GSR Team electronically. The GSR Team suggests that hard copies be minimized to the extent possible, and that lab data and other appendices be distributed on disk instead of as hard copies.

BMP A-6: Utilize teleconferences rather than meetings when feasible	**Date:** 4/10/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Teleconferencing is utilized as much as possible. Quarterly meetings with the RAB and monthly meetings with the BRAC Closure Team (BCT) are conducted in person, and the Project Team stated that those in-person meetings are appropriate. For the BCT meeting, some participants travel from a significant distance (ex: California, New Jersey).

BMP Category A: Planning

BMP A-7: Incorporate green specifications into solicitations and contracts Examples: - Follow pertinent green procurement policies - Select hotel chains with "green" policies - Select laboratories that utilize renewable energy	**Date:** 4/10/12 ☒ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☒ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Given the specialized nature of the work that is expected to be performed (i.e., specialized contractor), qualifications of the contractor will likely take precedence over green considerations with respect to contractor procurement. However, to the extent that GSR considerations can be included in work scopes and/or subcontracts (e.g., to reduce idling time for equipment) they should be. This could be further addressed as the constructability process continues.

BMP A-8: Integrate schedules to allow for resource sharing and fewer days of field mobilization	**Date:** 4/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Not clear if this BMP will be applicable for this scope of work, which is fairly "linear" in scope.

BMP Category A: Planning

BMP A-9: Explore multiple site reuse options, including those that include some restriction of site reuse and related resource conservation	**Date:** 4/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

The barrier wall that is the topic of the constructability evaluation is not expected to impact future land use positively or negatively.

BMP A-10: Conduct thorough review of project documents and historical records to minimize required scope of investigation Examples: - IRP projects: determine if there are previous aquifer tests that can be used for groundwater modeling rather than conducting new aquifer tests - MMRP projects: perform careful review of historic documents, aerial photographs, and other existing information to reduce the footprint of land that needs to be disturbed for thorough investigation and remediation - MMRP projects: use IRP sampling data to supplement and enhance the MMRP field program (if available)	**Date:** 4/10/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Historical information going back decades has been incorporated into the CSM.

BMP Category B: Characterization and/or Remedy Approach

BMP B-1: Develop and routinely update a conceptual site model (CSM) to use as a basis for making remedial process decisions	**Date:** 4/10/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *A great deal of effort has already been made in updating the CSM as a basis for remedy decisions. The cost and up-front investment regarding GSR are hard to quantify. The proposed pre-construction investigation will aid in further developing the CSM.*	

BMP B-2: Perform frequent optimization evaluations to improve efficiency of current or planned actions and/or develop alternative remedial approaches that might shorten remedy duration or otherwise improve the net environmental benefit of the remedy	**Date:** 4/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP does not really apply to the barrier wall construction.*	

BMP Category B: Characterization and/or Remedy Approach

<table>
<tr><td colspan="2">BMP B-3: Use appropriate characterization or remedy approach based on site conditions
Examples:
- Consider in-situ and passive remedy options that offer adequate protectiveness
- Consider in-situ bioremediation if conditions are already anaerobic and constituents are conducive to reductive dechlorination
- Compare source removal versus in-situ and ex-situ remedial options
- Consider different technologies for impacted areas with higher and lower concentrations
- Use realistic times to remedy closeout (i.e., estimations through modeling) rather than assumed remedy timeframes (e.g., 30 years), which is often used for evaluation of FS alternatives
- MMRP projects: evaluate man-portable DGM instruments versus vehicle-towed array (VTA) instruments and inclusion of detector-aided reconnaissance (DAR)</td><td>Date: 4/10/12

☒ Applicable
☒ Evaluated
☒ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A</td><td colspan="2">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☒ Economic ☒ Social</td><td colspan="2">Level of Up-Front Investment Included in 5 Year Cost Impact:
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<tr><td colspan="2">Resources Conserved:
☒ Hazardous air pollutants ☒ Energy ☒ Waste
☒ Criteria pollutants ☒ Materials ☒ Safety/Community
☒ GHG emissions (CO2e) ☒ Water ☒ Land-use</td><td>☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Notes (including discussion of possible value of implementing the BMP):

There was significant work to properly characterize and pick the proper remedy approach, and the recent activities are an attempt to develop and evaluate alternatives to the current remedy given site conditions. The cost and up-front investment regarding GSR are hard to quantify.</td></tr>
</table>

<table>
<tr><td colspan="2">BMP B-4: Establish decision points to trigger a change from one technology to another or from one remedy alternative to another
Examples:
- Change vapor treatment from thermal oxidation to granular activated carbon (GAC) media based on flow rates and concentrations
- Remove a treatment polishing step if influent to that step already meets discharge criteria
- Move to Monitored Natural Attenuation (MNA) if specific concentration thresholds in groundwater are met</td><td>Date: 4/10/12

☐ Applicable
☐ Evaluated
☐ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A</td><td colspan="2">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social</td><td colspan="2">Level of Up-Front Investment Included in 5 Year Cost Impact:
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<tr><td colspan="2">Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td>☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Notes (including discussion of possible value of implementing the BMP):

This BMP does not apply to the barrier wall construction.</td></tr>
</table>

BMP Category B: Characterization and/or Remedy Approach

<table>
<tr><td colspan="3">BMP B-5: Focus sampling efforts to meet objectives of the specific remedial phase (e.g., sampling during O&M should be focused on evaluating remedy performance and not on thorough plume characterization)
Examples:
- Eliminate sampling parameters as appropriate
- Reduce sampling frequency as appropriate
- Reduce sample locations as appropriate
- Enhance monitoring program as appropriate
- MMRP projects: consider Incremental Sampling Methodology (ISM) versus discrete sampling for MC characterization</td><td>Date: 4/10/12

☒ Applicable
☒ Evaluated
☒ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☒ Economic ☒ Social</td><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
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<tr><td colspan="2">Resources Conserved:
☒ Hazardous air pollutants ☒ Energy ☒ Waste
☒ Criteria pollutants ☒ Materials ☒ Safety/Community
☒ GHG emissions (CO2e) ☒ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

Sampling during well construction and borehole drilling has been developed based on the intended purpose of each drilling location. For example, blow counts, split spoons, rock cores and groundwater samples will not be collected at proposed piezometer locations because these wells are only intended for water level monitoring.</td></tr>
</table>

BMP Category B: Characterization and/or Remedy Approach

<table>
<tr><td colspan="2">BMP B-6: Consider real-time measurements and dynamic work plans to reduce mobilizations and improve effectiveness of investigation efforts
Examples:
- Field test kits (e.g., test kits for sulfate)
- Field screening instruments (e.g., x-ray fluorescence for lead or photoionization detectors for volatile organics)
- Drive point sensor technologies (e.g., membrane interface probe or “MIP”)
- Visual staining or odor
- Establish excavation extent based on real-time data collected as excavation proceeds and use GPS to accurately delineate excavation areas
- MMRP projects: use GPS and/or the same equipment that was used for detection to confirm anomaly signatures prior to excavating
- MMRP projects: consider incorporating field screening methods (e.g., X-ray fluorescence, EXPRAY and explosives test kits, as appropriate or applicable) into the field program to refine sampling locations and reduce the quantities of samples submitted for off-site laboratory analysis</td><td>Date: 4/10/12

☒ Applicable
☒ Evaluated
☒ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A</td><td colspan="2">Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☒ Economic ☒ Social</td><td colspan="2">Level of Up-Front Investment Included in 5 Year Cost Impact:
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<tr><td>Resources Conserved:
☒ Hazardous air pollutants ☒ Energy ☒ Waste
☒ Criteria pollutants ☒ Materials ☒ Safety/Community
☒ GHG emissions (CO2e) ☒ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Notes (including discussion of possible value of implementing the BMP):

Field arsenic profiling will be implemented during construction of the overburden well to determine screen length and location.</td></tr>
</table>

BMP Category B: Characterization and/or Remedy Approach

BMP B-7: Consider use of existing site structures/infrastructure or mobilization of temporary structures versus new construction

Examples:

- Buildings (e.g., for treatment building or field office)
- Concrete slabs or foundations
- Wells
- Existing excavations for storm water control

Date: 4/10/12

☒ Applicable
☒ Evaluated
☐ Practical

Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Application of this BMP is not feasible for this project. The current P&T building cannot be used for a "command center" for the remedial activities, so construction trailers will need to be rented.

BMP B-8: Establish project-specific decision points to limit extent of remediation

Examples:

- Project-specific cleanup levels based on a site-specific risk assessment (coordinated with risk assessment experts) rather than generic cleanup levels, if it results in lower footprints for key parameters and is acceptable to all stakeholders
- MMRP projects: dig stopping rules and anomaly prioritization/detection criteria to minimize false positives

Date: 4/10/12

☐ Applicable
☐ Evaluated
☐ Practical

Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

This BMP does not apply to the barrier wall construction. The wall length will be defined by constructability plan and the depth will be defined by the bedrock.

BMP Category B: Characterization and/or Remedy Approach

<table>
<tr><td colspan="3">BMP B-9: Consider leaving in place structures whose removal is not necessary (i.e., foundations, underground pillars, etc.)</td><td>Date: 4/10/12
☐ Applicable
☐ Evaluated
☐ Practical</td></tr>
<tr><td>Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
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<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
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<tr><td colspan="2">Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☒ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

This BMP does not apply to the barrier wall construction because no structures are in the vicinity of the construction.</td></tr>
</table>

BMP Category C: Energy/Emissions – Transportation

BMP C-1: Reduce the number of trips for personnel Examples: - Encourage carpooling - Use telemetry systems and webcams to remotely transmit data directly to project offices to avoid trips	**Date:** 4/10/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☐ Waste ☒ Criteria pollutants ☐ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Efforts are made to reduce the number of trips for field work and to couple jobs when possible.

BMP C-2: Reduce the number of trips and/or volume for transported materials, equipment, or waste Examples: - Transfer full loads by consolidating shipments from vendors and/or shipments to disposal sites (also share shipments with neighbors if feasible) - Purchase more concentrated chemicals to reduce transportation weight and/or volume	**Date:** 4/10/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☐ Waste ☒ Criteria pollutants ☐ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

It is assumed that construction materials for this project will be sent in as few shipments as possible.

BMP Category C: Energy/Emissions – Transportation

<table>
<tr><td colspan="3">BMP C-3: Reduce trip lengths
Examples:
- Dispose of waste at closest appropriate facility
- Purchase materials, equipment, and services from local vendors
- Use locally produced supplies
- Select most efficient transportation route</td><td>Date: 4/10/12
☒ Applicable
☒ Evaluated
☐ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
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☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
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<tr><td colspan="2">Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

With respect to the specialty contractor, GSR considerations for this BMP are outweighed by the need for specialized contractors for the slurry wall construction and trip length will be determined based on location of that contractor. With respect to materials, it is suggested that the final constructability plan establish the closest possible location for obtaining materials.</td></tr>
</table>

<table>
<tr><td colspan="3">BMP C-4: Use alternate fuels or other options for transportation when possible
Examples:
- Compressed natural gas
- Biodiesel blends
- Ethanol blends
- Hybrid and/or electric
- Rail lines versus trucks
- Use a fuel efficient passenger car rather than a pickup truck if task allows</td><td>Date: 4/10/12
☐ Applicable
☐ Evaluated
☐ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
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<tr><td colspan="2">Resources Conserved:
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☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

Not likely applicable.</td></tr>
</table>

BMP Category D: Energy/Emissions – Equipment Use

BMP D-1: Consider and implement approaches to minimize engine idle times	**Date:** 4/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP should be considered during the construction planning phase, and if possible should be included in contract language with the equipment operators.*	

BMP D-2: Ensure peak operating efficiency of equipment to reduce energy use and emissions Examples: - Perform preventative maintenance and operate equipment per manufacturer instructions - Perform retrofits involving low-maintenance multi-stage filters for cleaner engine exhaust - Use synthetic oil to extend operating life (and reduce waste oil) - Purchase newer equipment with reduced emissions	**Date:** 4/10/12 ☒ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *It is assumed that the Project Team will request that equipment delivered to the site will be in peak operating condition.*	

BMP Category D: Energy/Emissions – Equipment Use

BMP D-3: Use alternate fuel options for equipment when possible Examples: - Compressed natural gas - Biodiesel - Ethanol blends - Ultra-low sulfur diesel, wherever available (and as required by engines with PM traps)	**Date:** 4/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Given the heavy equipment use (estimated 500 gallons of diesel per day) during the barrier wall construction, for several months, it would be reasonable during final constructability plan activities to determine if equipment utilizing alternate fuel options is feasible.

BMP D-4: Select appropriate equipment and/or power source for the job Examples: - Avoid using large excavators for small earthmoving projects - Use direct push methods when possible to reduce drilling duration - Compare potential use of electricity versus battery versus generator	**Date:** 4/10/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☐ Waste ☒ Criteria pollutants ☐ Materials ☐ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

When drilling, an attempt will be made to use the smallest rig possible. Several options for drilling methods were identified in the Draft Constructability Basis Report, and the most suitable drilling method will be selected based on site conditions.

BMP Category D: Energy/Emissions – Equipment Use

BMP D-5: Use variable frequency drives on motors (e.g., pumps, blowers), or replace oversized motors with properly sized motors	**Date:** 4/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP is not applicable for the barrier wall.*	

BMP D-6: Identify options for generating renewable energy for direct use in the remedy and/or for alternate use at or near the project site Examples: - Solar, wind, landfill gas (microturbines), combined heat and power, geothermal heat exchange - Applications for remote areas such as solar pumps or solar flares (if demand is not continuous, the need for a battery backup may be avoided) - Generate power or heat exchange from water to be discharged	**Date:** 4/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP is not applicable for the barrier wall.*	

BMP Category D: Energy/Emissions – Equipment Use

BMP D-7: Consider purchase of renewable energy certificates to offset emissions from the remedial activities	**Date:** 4/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP is not applicable to the long-term use of a barrier wall which does not use electricity. RECs could potentially be purchased to offset emissions associated with fuel use during barrier wall construction, but that would increase costs and is likely not going to be considered acceptable.*	

BMP D-8: Design/modify housing required for above-ground treatment components for energy-efficiency Examples: - Passive lighting - Compact fluorescent lighting (CFL) or light-emitting diode (LD) lighting - Timers and/or motion control sensors for lighting - Shading - Minimize heating and cooling needs (building size, insulation, etc.)	**Date:** 4/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP is not applicable for the barrier wall.*	

BMP Category D: Energy/Emissions – Equipment Use

BMP D-9: For remedies that involve groundwater or air extraction, optimize extraction to reduce flow rates (potentially beneficial with respect to energy use, materials usage, water resources, waste disposal, etc.)	**Date:** 4/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP is not applicable for the barrier wall.*	

BMP D-10: Consider pulsing for extraction of water or air to maximize mass removal per unit of time or energy, by extracting higher concentrations	**Date:** 4/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP is not applicable for the barrier wall.*	

BMP Category D: Energy/Emissions – Equipment Use

BMP D-11: Run electrical equipment during times of lower electric demand if possible (this does not reduce energy use but could lower cost and also can lower stress on the energy grid during periods of peak demand)	**Date:** 4/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP is not applicable for the barrier wall.*	

BMP Category E: Materials & Off-Site Services

BMP E-1: Use materials that are made from recycled materials Examples: - Steel - Asphalt - Plastics - Concrete	**Date:** 4/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Does not likely apply to the materials for the construction of the barrier wall.*	

BMP E-2: Optimize the amount of materials used Examples: - Experiment with different material amounts/doses - Consider alternate materials - Use timers or feedback loops and process controls for dosing - MMRP projects: minimize quantities of donor explosives for MEC destruction	**Date:** 4/10/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☒ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *It is assumed that constructability evaluation has incorporated the optimal amount of materials necessary for well construction and barrier wall construction.*	

BMP Category E: Materials & Off-Site Services

BMP E-3: Utilize less refined materials when feasible

Examples:

- Limestone instead of sodium hydroxide for pH adjustment
- Native fill instead of select fill

Date: 4/10/12

☒ Applicable

☒ Evaluated

☒ Practical

Implemented? ("N/A" if "Practical" not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☒ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☒ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

The soil bentonite slurry wall, that is preferred by the Project Team over either a cement bentonite slurry wall or a steel sheet pile wall, uses less refined material (soil rather than cement or steel, and soil is less refined than cement or steel).

BMP E-4: Identify opportunities for using by-products or "waste" materials from local sources in place of refined chemicals or materials

Examples:

- Cheese whey, molasses, compost, or off-spec food products for inducing anaerobic conditions
- Crushed concrete for use as fill
- Concrete from coal combustion byproducts

Date: 4/10/12

☒ Applicable

☒ Evaluated

☐ Practical

Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☐ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☒ Waste
☐ Criteria pollutants ☒ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

It is unlikely that off-site wastes would be identified to use for the barrier wall.

BMP Category E: Materials & Off-Site Services

BMP E-5: Reduce demand on Publicly Owned Treatment Works (POTWs) Examples: - Discharge treated water to groundwater or to surface water rather than POTW - Minimize amount of water requiring treatment	**Date:** 4/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

This BMP is not applicable for the barrier wall. There could be a small reduction in water to the POTW if treated water from the P&T system is used for barrier wall construction, but this would just be a short-term reduction.

BMP Category F: Water Resource Use

BMP F-1: Minimize water consumption Examples: - Sensors to turn off water when not needed - Low flow fittings - Minimize water needs for irrigation (landscape choices, use of mats and mulch)			**Date:** 4/10/12 ☒ Applicable ☒ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A		
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000		
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☒ Water ☐ Land-use		☐ BMP otherwise required? If checked, required by:	
Notes (including discussion of possible value of implementing the BMP): *The water use for the barrier wall needs to be determined by the proper construction specs and therefore the application of this BMP is outweighed by other considerations.*			

BMP F-2: Preferentially use less refined water resources when feasible Examples: - Use extracted groundwater instead of potable water for chemical blending - Capture and store rain/storm water for future use - Employ rumble grates with a closed-loop gray-water washing system			**Date:** 4/10/12 ☒ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A		
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000		
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☒ Water ☐ Land-use		☐ BMP otherwise required? If checked, required by:	
Notes (including discussion of possible value of implementing the BMP): *According to the Draft Constructability Basis Report, the Project Team has identified potential alternative sources of water (Plow Shop Pond or discharge water from the P&T Plant), and will determine later in the constructability process if these sources will be chemically compatible with the remedy construction.*			

BMP Category F: Water Resource Use

BMP F-3: Use extracted and treated water for beneficial purposes Examples: - Irrigation - Potable water - Industrial process water	**Date:** 4/10/12 ☒ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☒ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *According to the Draft Constructability Basis Report, the Project Team has identified the potential of using discharge water from the P&T Plant as an alternative source for construction.*	

BMP F-4: Promote groundwater recharge Examples: - Recharge extracted and treated water when beneficial uses of the water are not identified and reinjection is practical - Minimize site area covered by impervious surfaces to reduce runoff and maximize infiltration (unless such capping is a specific component of the remedial action)	**Date:** 4/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP is not applicable for the barrier wall. In fact, the constructability evaluation includes expanding the landfill cap to reduce recharge near the barrier wall, which is seen as a positive in this case.*	

BMP Category F: Water Resource Use

BMP F-5: Maintain water quality by preventing nutrient loading to surface water or groundwater Examples: - Use phosphate-free detergents instead of organic solvents or acids to decontaminate sampling equipment (if not required for some contaminants)	**Date:** 4/10/12 ☒ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☒ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

This potentially applies to equipment cleaning chemicals which could run off into Plow Shop Pond. It is suggested that the final constructability plan address the use of equipment cleaning chemicals that minimize such impacts.

BMP Category G: Waste Generation, Disposal, and Recycling

BMP G-1: Minimize drill cuttings and all other investigation derived waste (including personal protection equipment) Examples: - Direct push or sonic drilling to reduce drill cuttings - Low-flow sampling or passive diffusion bags (if applicable) to reduce purge water - When possible place drill cuttings on-site rather than off-site disposal	**Date:** 4/10/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Rotosonic drilling, which minimizes drill cuttings, is being considered. However, this does not appear to be a significant issue at this site, because drill cuttings are not considered hazardous and do not require off-site disposal; they are typically spread on the surface. In addition, purge water is discharged to the ground.*	

BMP G-2: Segregate excavated soil in pre-planned staging areas so that "clean" material can be deposited on-site and/or reused rather than transported for off-site disposal	**Date:** 4/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Does not really apply because all unused material is being considered for disposal on-site beneath the existing landfill cap, so no off-site disposal is anticipated.*	

BMP Category G: Waste Generation, Disposal, and Recycling

BMP G-3: Consider on-site treatment and re-use of soil instead of off-site disposal Examples: - Land farming - Above ground soil vapor extraction (SVE)	**Date:** 4/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

This BMP is not applicable for this project, although some excavated soils will be reused.

BMP G-4: Minimize need to transport and dispose hazardous waste Examples: - Consider delisting listed hazardous waste if waste is not characteristically hazardous waste - Segregate hazardous waste and non-hazardous waste	**Date:** 4/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

This BMP is not applicable for this project, as there is no hazardous waste anticipated.

BMP Category G: Waste Generation, Disposal, and Recycling

BMP G-5: When possible avoid/minimize use of hazardous/toxic materials that may require special handling or disposal

Examples:

- Cleaning solutions
- Pesticides
- Disposable batteries (use rechargeable batteries)
- MMRP projects: minimize Chemical Agent Contaminated Media (CACM) at RCWM sites.

Date: 4/10/12

☒ Applicable ☐ Evaluated ☐ Practical

Implemented? ("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☒ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☒ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

This potentially applies to equipment cleaning chemicals. It is suggested that the final constructability plan address the use of equipment cleaning chemicals that minimize toxicity to humans or habitat.

BMP G-6: Recycle or reuse materials rather than disposing of them

Examples:

- Cardboard
- Plastics
- Concrete
- Asphalt
- Steel and other metals
- Recovered oil/product
- Mulch/compost
- MMRP projects - recycle recovered Material Documented as Safe (MDAS) after inspection and certification that the remnants are free of explosive hazards

Date: 4/10/12

☒ Applicable ☒ Evaluated ☒ Practical

Implemented? ("N/A" if "Practical" not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☐ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☒ Waste
☐ Criteria pollutants ☒ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

To the maximum extent possible, excavated soils will be used for the construction of the slurry wall to minimize need to import materials.

BMP Category H: Land Use, Ecosystems, and Cultural Resources

BMP H-1: Minimize erosion and soil transport to surface water bodies Examples: - Quickly restore any vegetated areas disrupted by equipment or vehicles - Institute appropriate erosion controls during excavation such as silt fencing	**Date:** 4/10/12 ☒ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☒ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Although not included in the Draft Constructability Basis Report, it is assumed that the final constructability plan will incorporate soil erosion controls to be implemented during construction to minimize transport of sediment to Plow Shop Pond.*	

BMP H-2: Minimize disturbances to land Examples: - Establish well-defined traffic patterns for onsite activities to minimize disturbed areas - Consider non-intrusive investigation techniques (e.g., geophysical methods) to identify items like USTs and buried drums	**Date:** 4/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *No major disturbances are anticipated.*	

BMP Category H: Land Use, Ecosystems, and Cultural Resources

BMP H-3: Preserve/restore ecosystems to the extent possible Examples: - Limit the removal of trees and vegetation - Attempt to transplant disturbed shrubs and small trees to other locations - Use native species for re-vegetation - Retrieve dead trees during excavation and later reposition them as habitat snags - Select and place suitably sized and typed stones into water beds and banks - Undercut surface water banks in ways that mirror natural conditions - Cut back rather than remove trees, bushes, vegetation	**Date:** 4/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

The only disturbance would occur in the vicinity of the barrier wall. This would consist of open, grassy areas (no trees or other vegetation) which would be restored afterward.

This BMP is considered not applicable because the project team indicated that they did not believe that any of the construction would impact ecosystems in a significant way.

BMP H-4: Minimize drawdown of the water table in sensitive areas such as wetlands or areas subject to subsidence	**Date:** 4/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

The barrier wall does not involve groundwater extraction and therefore is not considered applicable.

BMP H-5: Construct wells and other remedial process infrastructure (piping, buildings, etc.) to minimize restrictions to anticipated future use of the site

Date: 4/10/12

☐ Applicable

☐ Evaluated

☐ Practical

Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

The recommended remedy being considered does not involve restriction on land use above and beyond the restrictions created by the landfill and existing conditions.

BMP H-6: Preserve/restore cultural resources to the extent possible
Examples:

- Protected lands such as wildlife refuges, national parks, and wilderness areas
- Culturally sensitive sites such as cemeteries, native burials, and archaeological finds
- Buildings or land parcels with historical significance

Date: 4/10/12

☐ Applicable

☐ Evaluated

☐ Practical

Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

There are no identified cultural resources in the area that would potentially be impacted by remediation activities for the identified alternatives.

BMP Category H: Land Use, Ecosystems, and Cultural Resources

<table>
<tr><td colspan="2">BMP H-7: Document sensitive ecological and cultural resources prior to initiating actions that might diminish or destroy those resources
Examples:
- Photodocument conditions prior to clearing brush
- MMRP projects: photodocument conditions prior to BIP</td><td>Date: 4/10/12
☐ Applicable
☐ Evaluated
☐ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A</td><td colspan="2">Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social</td><td colspan="2">Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td>Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Notes (including discussion of possible value of implementing the BMP):

There are no identified ecological or cultural resources in the area that would potentially be impacted by remediation activities.</td></tr>
</table>

BMP Category I: Safety and Community

BMP I-1: Minimize and mitigate noise, light and odor disturbance during all phases of the remedial process, to the extent practicable	**Date:** 4/10/12 ☒ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☒ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

There are no issues identified to date. The final constructability plan should specifically address if there are any anticipated restrictions or concerns regarding such disturbances (noise, light, odor, and visual aesthetics) during construction.

BMP I-2: Minimize dust during construction activities by spraying water or techniques such as laying biodegradable mats, tarps, or materials (already in EM385-1-1)	**Date:** 4/10/12 ☒ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☒ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☒ BMP otherwise required? If checked, required by: *EM385-1-1*

Notes (including discussion of possible value of implementing the BMP):

It is assumed that this BMP will be incorporated into the construction activities.

BMP Category I: Safety and Community

BMP I-3: Select transportation routes for trucks and heavy equipment that minimize impacts to residential areas to maximize safety and minimize noise and other aesthetic impacts	**Date:** 4/10/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < \$10,000 ☐ \$10,001 - \$50,000 ☐ \$50,001 - \$100,000 ☐ \$100,001 - \$500,000 ☐ > \$500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☒ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

A few residences exist along Scully Road, which provides access to the site. An alternate route to the south of the landfill goes by industrial areas only.

BMP I-4: Minimize drawdown of the water table in areas that could impact production rates at supply wells and/or irrigation wells	**Date:** 4/10/12 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < \$10,000 ☐ \$10,001 - \$50,000 ☐ \$50,001 - \$100,000 ☐ \$100,001 - \$500,000 ☐ > \$500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

This BMP is not applicable for this project.

BMP Category I: Safety and Community

BMP I-5: Minimize amount of time that heavy machinery is needed to enhance safety	**Date:** 4/10/12 ☒ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☒ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *It is assumed that this BMP will be applied during the construction of the recommended remedy (as a cost minimization strategy).*	

BMP I-6: Minimize handling of dangerous chemicals by selecting alternate chemicals and/or engineering to minimize contact with chemicals (for MMRP projects, there is enhanced risk related to explosion potential and exposure to chemical agents (CA) and agent breakdown products (ABP) associated with RCWM responses)	**Date:** 4/10/12 ☒ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☒ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *No specific chemicals for equipment cleaning have been identified. Ideally, the least hazardous chemicals that are suitable will be selected.*	

BMP Category I: Safety and Community

BMP I-7: Contribute to local economy when possible Examples: - Consider leasing local office space - Purchase or lease equipment from local vendors - Hire workers from local community	**Date:** 4/10/12 ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☒ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Personnel will use local hotels and eat in local restaurants.*	

BMP Category J: Other Site-Specific BMPs

BMP J-1:	**Date:**
	☐ Applicable ☐ Evaluated ☐ Practical

Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

BMP J-2:	**Date:**
	☐ Applicable ☐ Evaluated ☐ Practical

Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Appendix B

Assumptions for SiteWise Input and Other Calculations for Soil Bentonite (SB) Slurry Wall (Baseline Constructability)

Appendix B
Assumptions for SiteWise Input and Other Calculations
Shepley's Hill Landfill Pilot GSR Evaluation (Constructability Phase):
Soil Bentonite (SB) Slurry Wall (Baseline)

SiteWise "RA_Baseline_NoFR_1" Directory

According to the *Shepley's Hill Landfill Pre-Construction Investigation Workplan* (dated November 2011) and the *Draft Constructability Basis Report, Hydraulic Barrier Wall at Shepley's Hill Landfill* (dated 21 October 2011), it is expected that the selected remedy for the site will include installation of a hydraulic barrier wall to the east of the existing landfill, between the landfill and Plow Shop Pond. The purpose of the barrier wall is to mitigate the flux of arsenic to Plow Shop Pond by diverting groundwater flow to the north. The barrier wall is intended to have a hydraulic conductivity of 1×10^{-7} cm/sec or less, and have a minimum design life of 100 years. The site consultant (AMEC) indicated in the *Draft Constructability Basis Report* that a soil bentonite (SB) slurry wall is preferred versus other options (cement bentonite slurry wall or sheet piling) on the basis of cost as well as other sustainability considerations such as reducing waste and carbon footprint.

For the purposes of footprinting, this alternative is assumed to involve the following components:

- A pre-construction constructability investigation
- Barrier wall construction
- Barrier wall O&M (minimal cost of $5,000 per year estimated in the FS, no other specific footprints calculated)

SiteWise inputs are based on the information described in the *Pre-Construction Investigation Workplan*, the *Draft Constructability Basis Report*, and data provided directly by the Project Team (in cases where the Project Team's values differed from what was indicated in the documents, the values provided by the Project Team were used). When information required for SiteWise input was not provided, reasonable assumptions were made (these assumptions are noted in the description of SiteWise input below).

The notes pertaining to SiteWise input are organized by the following tabs of the SiteWise input sheet:

- Pre-Construction Investigation Activities – Uses *"Remedial Investigation"* tab of the SiteWise input sheet
- Pre-Construction Investigation Sampling– Uses *"Remedial Action Construction"* tab of SiteWise input sheet
- Slurry Wall Construction– Uses *"Remedial Action Operations"* tab of SiteWise input sheet

For each section of SiteWise, all the sections are listed, with pertinent information added only for those sections of the input sheet where data were added.

Baseline – Overview

In some cases, small quantities of materials (such as locks for monitoring wells) were not included in SiteWise input because the footprint of these items relative to the other materials used would be expected to be extremely minimal.

Other calculations done outside of SiteWise are then presented. These include the following:

- % of total energy from renewable resources
- Hazardous air pollutants
- Refined material use
- Unrefined material use
- Tons of non-hazardous waste
- Tons of hazardous waste
- % of Potential Waste Recycled
- Risks to on-site works and from transportation
- Heavy truck trips through residential areas

Additional tables are attached which show how SiteWise outputs were split into “direct” and “indirect” energy use and greenhouse gas emissions. For definitions of direct and indirect energy use and emissions, please refer to section 2.2.2 of the evaluation report.

Cost calculations are based on cost information provided in the December 2010 Draft FFS (in which the barrier wall remedy was identified as “Alternative B: Containment Wall”), since no updated costs were included in the constructability work plan. A summary cost sheet developed by the GSR Team is attached to this Appendix. Information regarding the cost calculations is as follows:

- The capital cost is $1,210,292 and occurs in year 0.

- The annual operating cost is $5,000, occurring each year in years 1 through 100.

- The sum of capital and annual costs, non-discounted, is $1,710,292.

- To determine net present value (NPV), a 2.7 percent discount rate is applied to future costs, which is consistent with the discount rate applied in the Draft FFS. NPV is calculated by discounting future costs to present-day dollars using the following equation:

$$PV = \frac{FV}{(1+i)^n} = C \times FV$$

  PV is the present value
  FV is the value in year “n” (i.e., future value)
  i is the discount rate
  C is the discount factor, which equals $1/(1+i)^n$

- The NPV calculated by the GSR Team is $1,382,578.

Baseline – Pre-Construction Investigation Activities

Scope of Work

Plans are to drill six exploratory borings (identified as SHM-11-01 through SHM-11-06), with SHM-11-02 completed as a bedrock well and SHM-11-06 completed as an overburden well. 10-foot rock core samples will be collected at each of these locations, with groundwater profiling for arsenic concentrations conducted at 10-foot sampling increments at locations SHM-11-02 and SHM-11-06. Additionally, two piezometers, identified as SHM-11-07 and SHM-11-08, will be installed to west of the proposed barrier wall location. The table below represents dimensions of boreholes and wells assumed by the GSR Team, based on descriptions in the site document *"Pre-Construction Investigation Workplan"*.

	SHM-11-01 boring	**SHM-11-02 MW-Bedrock**	**SHM-11-03 boring**	**SHM-11-04 boring**	**SHM-11-05 boring**	**SHM-11-06 MW – overburden**	**SHM-11-07 piezometer**	**SHM-11-08 piezometer**
depth (feet)*	50	65	25	50	30	50	30**	30**
well casing material	-	Outer casing of steel, bedrock portion open hole	-	-	-	PVC	PVC**	PVC **
casing diameter (in)	-	4**	-	-	-	2	2**	2**
borehole diameter (in)**	4	6	4	4	4	4	4	4
sand filter (ft)*	-	0	-	-	-	12.5*	7.5*	7.5*
Bentonite Seal (ft)*	-	0	-	-	-	2	2	2
Grouting (ft)*	50	10	25	50	30	27.5*	22.5*	22.5*
drilling method	drive and wash						hollow-stem auger (assumed)	
time (days)**	2	2	1	2	2	2	2	2

***Depths estimated based on site documents which indicate "40 to 65 feet" for well depth and "2-3 ft above screen" for filter pack**
****Assumed based on professional judgment of GSR team. For bedrock well assume outer steel casing will be 4 inch diameter**

The GSR Team assumes that 2 drillers will come from a distance of 50 miles one way (via light truck) and make one round trip per day, and assumes the drill rig will come from a distance of 50 miles one way and will be left on-site during drilling. The GSR Team assumes 1 on-site contractor will be present to supervise drilling, and will be traveling 20 miles one way, making one round trip per day.

The GSR Team assumed no significant footprint for the gate boxes or protective casings (i.e., well covers), and therefore did not include them in the SiteWise input.

The GSR Team is assuming the use of hollow stem auger for the drilling of all boreholes for footprinting (it is assumed that footprint would not be much different for drive and wash).

The GSR Team is assuming the use of an NxQ rock bore barrel for the collection and evaluation of the underlying bedrock. This activity is included as part of the drilling for footprinting purposes.

Baseline – Pre-Construction Investigation Activities

The GSR Team is assuming the use of a 4-hour pump test and packer testing/rising head aquifer testing to evaluate bedrock hydraulic conductivity. This activity was considered negligible for footprinting.

The GSR Team is assuming the use of a geophysical survey to evaluate bedrock contour and depth along the path of the proposal barrier wall. This activity was considered negligible for footprinting.

Baseline – Pre-Construction Investigation Activities

<u>Input into "Remedial Investigation" tab of SiteWise Input Sheet.xls</u>

- Baseline Information
  - Remedial Investigation Cost
    - Total remedial investigation cost ($) – leave blank in SiteWise

- Material Production
  - Well Materials
    - Well Type 1-Represents the PVC for screen and casing of the overburden monitoring well and the two piezometers. Three wells, assumed an average of 36.6 feet deep, PVC (assumed Schedule 40) and 2 inch casing diameter.
    - Well Type 2-Represents the steel outer casing for the bedrock monitoring well. One well, assumed an average of 65 feet deep, Steel (assumed Schedule 40) and assumed 4 inch casing diameter (the steel represents the outer casing through the overburden).
  - Treatment Chemicals & Materials
  - Treatment Media
  - Construction Materials
  - Well Decommissioning
  - Bulk Material Quantities
    - Material 1- Sand filter pack for overburden well and 2 piezometers. Select "sand" and "cubic feet". To calculate volume of sand, determine total volume within borehole ($V=\pi*(2/12)^2*$interval) and subtract volume within well casing ($V=\pi*(1/12)^2*$interval) for the interval where sand will be present. For the three wells, total interval height is 12.5 + 7.5+7.5 = 27.5 feet total. Total volume of sand calculated is 1.80 cubic feet.
    - Material 2-Bentonite Seal for overburden well and 2 piezometers. Select "Bentonite" and "cubic feet". To calculate volume of bentonite, determine total volume within borehole ($V=\pi*(2/12)^2*$interval) and subtract volume within well casing ($V=\pi*(1/12)^2*$interval) for the interval where bentonite will be present. For the three wells, total interval height is 2+2+2 = 6 feet. Total volume of bentonite calculated is 0.39 cubic feet.
    - Material 3-Grout for overburden well and 2 piezometers. Select "Typical cement" to represent grout. Select "cubic feet". To calculate volume of grout, determine total volume within borehole ($V=\pi*(2/12)^2*$interval) and subtract volume within well casing ($V=\pi*(1/12)^2*$interval) for the interval where grout will be present. For the three wells, total interval height is 27.5 + 22.5+ 22.5 = 72.5 feet. Total volume of grout calculated is 4.74 cubic feet.
    - Material 4-Grout for bedrock well. Select "Typical cement" to represent grout. Select "cubic feet". To calculate volume of grout, determine total volume within borehole ($V=\pi*(3/12)^2*$interval) and subtract volume within well casing ($V=\pi*(2/12)^2*$interval) for the interval where grout will be present of 10 feet. Total volume of grout calculated is 1.96 cubic feet.
    - Material 5-Grout for four other borings. Select "Typical cement" to represent grout. Select "cubic feet". To calculate volume of grout, determine total volume within borehole ($V=\pi*(2/12)^2*155$ (total length of SHM-11-01, SHM-11-03, SHM-11-04, and SHM-11-05). Total volume of grout calculated is 13.53 cubic feet

Baseline – Pre-Construction Investigation Activities

- Transportation
  - Personnel Transportation – Road
    - Trip 1- Light truck for drillers. Select gasoline. Two drillers travelling from a distance of 100 miles round trip, one trip per day for sixteen days.
    - Trip 2- Heavy duty truck to represent drill rig. Select "diesel", 100 miles round trip, one round trip to bring rig to and from site (assume rig left on-site for length of drilling). Select "1" passenger.
    - Trip 3-On-site consultant. Select "light truck" and "gasoline". Travelling distance is assumed by GSR team to be 40 miles round trip, one trip per day for sixteen days. One passenger.
  - Personnel Transportation – Air
  - Personnel Transportation – Rail
  - Equipment Transportation – Road
    - Trip 1-Transport of well casing materials. Select "diesel" and 50 miles one way. Estimated total weight (from SiteWise output sheet) equals 79 lbs (PVC) plus 701 lbs (steel) = 780 lbs = 0.39 tons.
    - Trip 2-Transport of sand, bentonite and grout. Select "diesel" and 50 miles one way. Total weight of all sand, bentonite and grout were obtained from SiteWise output file and equals 94.3 kg (sand) + 19.9 kg (bentonite) + 202.1 kg (cement) + 83.6 kg (cement) + 577.0 kg (cement) = 976.9 kg = 2,149 lbs = 1.07 tons.
    - Trip 3- Return trip of both empty material delivery trucks. Select "diesel" and 100 miles (2 trucks travelling 50 miles one way). Total weight is zero tons.
  - Equipment Transportation – Air
  - Equipment Transportation – Rail
  - Equipment Transportation – Water

- Equipment Use
  - Earthwork
  - Drilling
    - Event 1- Drilling for eight boreholes. Select "Hollow Stem Auger" for drilling method. GSR team assumes an average of two days for each borehole, for 16 hours per location. Choose "diesel" for fuel type.
  - Trenching
  - Pump Operation
  - Diesel and Gasoline Pumps
  - Blower, Compressor, Mixer, and Other Equipment
  - Generators
  - Agricultural Equipment
  - Capping Equipment
  - Mixing Equipment
  - Internal Combustion Engines
  - Other Fueled Equipment
  - Operator Labor
  - Laboratory Analysis
  - Other Known Onsite Activities

- Residual Handling
  - Residue Disposal/Recycling

- Landfill Operations
- Thermal/Catalytic Oxidizers

- Resource Consumption
  - Water Consumption
  - Onsite Land and Water Resource Consumption

Once SiteWise input is complete, go to "SiteWise_Input Sheet " for overall project and enter information (including Alternative File Name "Baseline"). Then go to "Generate Alternative" tab and click button labeled "Click to generate alternative using previously entered alternative name". Copies of the input and output summary sheets for this alternative are now located in the directory titled "RA_Baseline _NoFR_1". To store the "Remedial Action Investigation.xls" calculation sheet showing detailed calculations, open it in the overall SiteWise project directory when the appropriate input sheet is open, then do a "save as" to put it in the directory for this alternative using a name that indicates "will not update". Then open that file and do "data->edit links" and break the links. If the input sheet for this alternative ever changes, then this calculation sheet needs to be re-saved.

To edit input parameters for this alternative, you must go back to the ORIGINAL SiteWise input sheet and import this alternative using the "Do you want to reload a previously saved remedial alternative in the SiteWise input sheet?" field on the "Site Info" tab. After making necessary changes to the input sheet, re-export the alternative by going to the "Generate Alternative" tab and clicking the button labeled "Click to replace an existing alternative with the same name". Update saved calculation sheets as described above.

Baseline – Pre-Construction Investigation Sampling

<u>*Scope of Work*</u>

SHM-11-01 (Bore hole only)

- Split spoon (includes one geotechnical sample)
- Blow counts
- Rock cores

SHM-11-02 (Open hole Bedrock well with steel outer casing)

- Split spoons (includes one geotechnical sample)
- Blow counts
- Rock cores up to 15 ft into bedrock
- Rising head slug test/packer testing and 4-hour pump test
- Profiling samples at 10 ft intervals below the water table (submitted to lab and analyzed for As)
    - GW will be purged using a stainless steel bladder pump or a peristaltic-inertial pump
- Groundwater sampled for TAL metals and ammonia using low flow
- Water elevations collected

SHM-11-03

- Split spoon (includes one geotechnical sample)
- Blow counts
- Rock cores

SHM-11-04 and SHM-11-05

- No split spoons, and blow counts only if there is significant variability for the first three boreholes
- One geotechnical sample if significant variability in subsurface conditions detected in SHM-11-01 through SHM-11-03.
- Rock cores

SHM-11-06 (Overburden monitoring well)

- No split spoons, and blow counts only if there is significant variability for the first three boreholes
- One geotechnical sample if significant variability in subsurface conditions detected in SHM-11-01 through SHM-11-03.
- Rock cores
- Groundwater sampled for TAL metals and ammonia using low flow
- Profiling samples at 10 ft intervals below the water table (submitted to lab and analyzed for As)
    - GW will be purged using a stainless steel bladder pump or a peristaltic-inertial pump
- Water elevations collected

SHM-11-07 and SHM-11-08 (Piezometers)

- Soil samples and rock samples are not collected
- No blow counts collect
- Profiling samples at 10 ft intervals below the water table (submitted to lab and analyzed for As)
    - GW will be purged using a stainless steel bladder pump or a peristaltic-inertial pump
- Water elevations collected

Baseline – Pre-Construction Investigation Sampling

Transport of samples to laboratories:

- Assume ground courier to a groundwater lab, and separate courier to a geotechnical lab. Assume distance not to exceed 50 miles one way in each case. Assume that samples will account for approximately 50% of the courier's load.
- Assume all geotechnical samples in one shipment.
- Assume one groundwater sampling shipment for each well of 4 wells/piezometers to be profiled, plus 1 combined groundwater sampling shipment for the two wells to be sampled low-flow (i.e., 5 total shipments for groundwater sampling).

Baseline – Pre-Construction Investigation Sampling

Input into “Remedial Action Construction” tab of SiteWise Input Sheet.xls

- Baseline Information
  - Remedial Action Construction Cost
    - Total remedial action construction cost ($) – leave blank in SiteWise

- Material Production
  - Well Materials
  - Treatment Chemicals & Materials
  - Treatment Media
  - Construction Materials
  - Well Decommissioning
  - Bulk Material Quantities

- Transportation
  - Personnel Transportation – Road
    - Trip 1-Represents the on-site consultant that performs low-flow sampling. Select “light truck” and “gasoline”. GSR team assumed a 40 mile round trip distance, with 1 trip taken, with 1 traveler.
  - Personnel Transportation – Air
  - Personnel Transportation – Rail
  - Equipment Transportation – Road
    - Trip 1- Represent courier transport of geotechnical samples and rock cores. Select “gasoline”. GSR team estimated trip to be a one way distance of 50 miles. Weight of rock cores and geotechnical samples were estimated by GSR team to be approximately 0.5 tons (rough estimate).
    - Trip 2-Represent courier transport of groundwater samples. Select “gasoline”. Distance was calculated by assuming five separate trips of 50 miles each with site samples accounting for 50% of total courier load (5*50*0.5=125 miles). Assumed cooler weights to be 20 lbs. each (=0.01 tons).
    - Trip 3-Represents empty trips to pick up samples from site. Total distance equals sum of mileage for trips 1 and 2, above (50+125=175 miles). Enter “0” for weight.
  - Equipment Transportation – Air
  - Equipment Transportation – Rail
  - Equipment Transportation – Water

- Equipment Use
  - Earthwork
  - Drilling
  - Trenching
  - Pump Operation
  - Diesel and Gasoline Pumps
  - Blower, Compressor, Mixer, and Other Equipment
  - Generators
  - Agricultural Equipment
  - Capping Equipment
  - Mixing Equipment

- Internal Combustion Engines
- Other Fueled Equipment
- Operator Labor
- Laboratory Analysis
- Other Known Onsite Activities

- Residual Handling
  - Residue Disposal/Recycling
  - Landfill Operations
  - Thermal/Catalytic Oxidizers

- Resource Consumption
  - Water Consumption
  - Onsite Land and Water Resource Consumption

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Baseline – Slurry Wall Construction

<u>*Scope of Work*</u>

- Barrier wall that is 800 to 950 feet long, 50 to 60 feet horizontal depth, 2.5 feet wide (*Draft Constructability Basis Report, p.5)*.
    - Materials
        - 400 tons of bentonite borrow for excavation of the trench and preparation of the backfill (*Draft Constructability Basis Report, p.6)*
        - Backfill for SB slurry wall will likely consist of excavated soils supplemented with 35% imported plastic fines/clay which is estimated by the Project Team to require 1300 cubic yards of clay (*Draft Constructability Basis Report, p.6)*
    - Transport of materials to site
        - Assume transport of any of the above materials would come from a distance no greater than 20 miles
    - Waste Disposal
        - Process will generate approximately 1300 to 1850 cubic yards of excess soil cuttings (*Draft Constructability Basis Report, p.5)* as well as 75-100 cubic yards of excess Bentonite Water (BW) slurry that will require stabilization and disposal (*Draft Constructability Basis Report, p.5)*. Based on text in the *Draft Constructability Basis Report,* the GSR team assumes this will be deposited under the existing landfill cap on-site using machinery already mobilized to the site, and therefore no separate footprint is calculated for waste disposal and no landfill volume is calculated because this waste is not displacing any potential landfill space for other wastes such as would be the case if these items were placed in an off-site landfill.

- Transport of personnel to and from site
    - Specialty contractor for construction likely to come from Maryland, Pennsylvania or New Jersey (GSR Team assumes approximately 300 miles one-way from site). The GSR Team assumes 2 personnel from specialty contractor will be at the site for 7 weeks with 4 trips home. The GSR Team assumes 8 additional personnel (site contractors and equipment operators) will be local from within 30 miles of the site on average. The GSR Team assumes specialty personnel stay at hotel within 5 miles of site.

- Landfill cap
    - Expansion of the existing landfill cap between the barrier and the landfill to minimize infiltration in that area (*Draft Constructability Basis Report* , p.5) appears minimal, estimated by the GSR Team to be ~3,750 square feet based on maps)
    - Materials
        - 300 ml polyvinylchloride (PVC) membrane cap (*Draft Constructability Basis Report* , p.2)
        - Soil and vegetation cover (assumed by GSR team to require imported clean fill for depth of 2 ft)
- Platform
    - Materials
        - Will need to import 2,400 to 2,800 cubic yards of sand/gravel borrow (*Draft Constructability Basis Report*, p.5). The GSR Team will assume 2,600 cubic yards.
- Equipment use
    - Equipment (*Draft Constructability Basis Report, p.8)*
        - CAT 365/Komatsu PC-1250 excavator (bucket width 2-3 feet)

    - Long reach trenching attachment (not available locally)
    - CAT 950 front end loader, or similar
    - AT325 excavator, or similar
    - CAT D5, or similar- used to mix slurry adjacent to the trench and place mixed backfill into trench
    - Slurry mixing plant
    - (3-4) 20, 000 gallon slurry tanks
    - Slurry pumps, hoses and piping
    - 100kW generator, assuming that no commercial power is available
  - The Project Team estimates that total fuel consumption is estimated to be approximately 500 gallons of diesel per day for 6-8 weeks (*Draft Constructability Basis Report, p.8.* Unless otherwise noted, the GSR Team assumes this fuel consumption will account for all equipment usage noted above. The GSR Team informally reviewed this fuel usage estimate and considers it to be reasonable.
  - Transport of equipment to and from site
    - Assume the slurry mixing plant coming from specialty contractor, assumed to be 300 miles away (one way)
    - Assume transport of the rest of the equipment (and fuel for that equipment) would come from a distance no greater than 50 miles one way
- Water consumption
  - Approximately 100,000 gallons "per shift" (*Draft Constructability Basis Report, p.8*). Each shift is ~8-hours based on the 200 gpm estimate provided in the *Draft Constructability Basis Report*
  - Based on the *Draft Constructability Basis Report (p.8*), water sources may include a local hydrant (assumed to represent potable water) and/or water from the pond (assumed to represent non-potable water) or treated water from the treatment plant (which otherwise goes to the POTW and is assumed to represent non-potable water). The GSR Team assumes for the baseline alternative utilizes potable water from the hydrant.

Baseline – Slurry Wall Construction

Input into "Remedial Action Operations" tab of SiteWise Input Sheet.xls

- Baseline Information
  - Remedial Action Operations Cost and Duration
    - Total remedial action operations cost ($) – leave blank in SiteWise
    - Duration of remedial action operations (unit time) – 1 yr for this GSR evaluation because we have multiplied input items by number of years as part of the input

- Material Production
  - Well Materials
  - Treatment Chemicals & Materials
  - Treatment Media
  - Construction Materials
  - Well Decommissioning
  - Bulk Material Quantities
    - Material 1- Bentonite borrow for excavation of trench and preparation of backfill. Select "Bentonite", pounds, and 400 tons * 2000 pounds per ton=800,000.
    - Material 2- Plastic fines (35% clay borrow) for SB backfill. Select "Soil" to represent borrow, cubic feet, and 1300 cubic yards *27 cubic feet per cubic yard=35,100 cubic feet.
    - Material 3-Sand/gravel borrow for working platform for slurry wall construction-Select Gravel to represent sand/gravel borrow, unit is cubic feet, input material quantity is assumed to be the average of 2400 to 2800=2,600 cubic yards, cubic feet of material=2600*27=70,200 cubic feet
    - Material 4-PVC liner for extension of landfill cap, in pounds, with 30 mil PVC=0.2 lbs per square foot (internet research), and estimated addition to cap (from maps) 3,750 square feet=0.2*3,750=750 pounds.
    - Material 5- Soil to cover PVC liner for extension of landfill cap. Select "cubic feet". Soil estimated to be 2 feet thick over 3,750 square feet extension=7,500 cubic feet.
- Transportation
  - Personnel Transportation – Road
    - Trip 1-Slurry wall specialty contractor traveling from out of state. Assume cars, gasoline, 600 miles round trip (average distance from places that contractors are expected to come from), assume 4 round trips over the 7 weeks to site for 1 vehicle, 2 passengers per vehicle.
    - Trip 2-Slurry wall contractor traveling from hotel and out for lunch. Assume cars, gasoline, 10 miles round trip (average distance from nearby hotels), assume two round trips to site per day for 5 days per week for 7 weeks, for 1 vehicle, 2 passengers per vehicle.
    - Trip 3-Local Project team consultant and operators traveling from home to site for work. Assume a light truck, gasoline, 60 mile round trip, 8 trips per day for 5 days per week for 7 weeks, 1 traveler per vehicle.
  - Personnel Transportation – Air
  - Personnel Transportation – Rail
  - Equipment Transportation – Road

        - Trip 1-Transport of all equipment (and associated fuel) listed in Scope of Work to and from site except slurry mixing plant. Select diesel, distance traveled is assumed to be 100 miles round trip for 10 vehicles, each carrying 20 tons of equipment (the number of vehicles and tons is a rough estimate by the GSR Team, no detailed analysis was performed).
        - Trip 2-Return trip for empty vehicles in Trip 1, Select diesel, 10 vehicles traveling 100 miles round trip carrying 0 tons of weight.
        - Trip 3- Transport of Bentonite, plastic fines, sand/gravel borrow, PVC liner and soil for cap, equal to total of 6,533 tons, (obtained from SiteWise output file). Select diesel, and input the total distance as 3,260 miles (assuming each vehicle will hold 40 tons, this will require approximately 163 vehicles and assume each trip is 20 miles one way.
        - Trip 4-Return trip for vehicles that transported above materials in Trip 3. The total distance is 3,260 miles from 163 vehicles going 20 miles, one way. Each vehicle will hold 0 tons.
        - Trip 5 - Transport of slurry mixing plant. Select diesel, distance traveled is assumed to be 600 miles round trip for 1 vehicle, carrying 20 tons of equipment (the number of vehicles and tons is a rough estimate by the GSR Team, no detailed analysis was performed).
        - Trip 6 – Return trip for vehicles that transported slurry mixing plant in Trip 5. The total distance is 600 miles from 1 vehicles going 600 miles round trip. Each vehicle will hold 0 tons.

    - Equipment Transportation – Air
    - Equipment Transportation – Rail
    - Equipment Transportation – Water

- Equipment Use
    - Earthwork
    - Drilling
    - Trenching
    - Pump Operation
    - Diesel and Gasoline Pumps
    - Blower, Compressor, Mixer, and Other Equipment
    - Generators
    - Agricultural Equipment
    - Capping Equipment
    - Mixing Equipment
    - Internal Combustion Engines
        - Engine 1-Representing total fuel consumption for all fuel use in Scope of Work (approximately 500 gallons per day for seven weeks), Select diesel, input fuel consumption=(500/8)=62.5 gallons per hr, and input operating hours=8 hrs/d* 5 days per week*7 weeks =280 hours.
    - Other Fueled Equipment
    - Operator Labor
    - Laboratory Analysis
    - Other Known Onsite Activities

        - Water consumption (gallon)- represents all water required for construction to include local hydrant and/or water from pond or treated water from the treatment plant, unknown distribution. Total use=100,000 gal per day*5 days per week*7 weeks=3,500,000 gallons

- Residual Handling
    - Residue Disposal/Recycling
    - Landfill Operations
    - Thermal/Catalytic Oxidizers

- Resource Consumption
    - Water Consumption
    - Onsite Land and Water Resource Consumption

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Other Supporting Calculations:
Soil Bentonite (SB) Slurry Wall (Baseline)

% of Total Energy Usage from Renewable Resources

- None identified (since remedy construction will not require electricity use)

Hazardous Air Pollutants

- None identified

.

Refined Materials Use

Material	Lbs	Basis
PVC (well casing)	79	Calculated by SiteWise output file
Steel (well casing)	701	Calculated by SiteWise output file
Cement (grout for overburden well and 2 piezometers)	444.7	Calculated by SiteWise output file
Cement (grout for bedrock well)	183.9	Calculated by SiteWise output file
Cement (grout for other borings)	1,269.2	Calculated by SiteWise output file
PVC (liner for cap extension)	750	Calculated by GSR Team
Total	***3,427.8 lbs***	

Unrefined Materials Use

Material	Tons	Basis
Plastic fines (SB backfill)	2022.6	Calculated by SiteWise output file
Bentonite (seal on wells)	0.1	Calculated by SiteWise output file
Sand (filter packs)	0.1	Calculated by SiteWise output file
Bentonite (borrow for trench)	400	Calculated by GSR Team
Sand/gravel (borrow for platform)	3,677.9	Calculated by SiteWise output file
Soil (cover for cap extension)	432.2	Calculated by SiteWise output file
Total	***6,532.9 tons***	

Tons of Non-Hazardous Waste

- None identified (will be placed under existing cap with equipment already mobilized to the site)

Tons of Hazardous Waste

- None identified

Baseline – Other Supporting Calculations

% of Potential Waste Recycled

- N/A

Risks to On-Site Workers and from Transportation

- Based on SiteWise output
    - On-Site worker injuries or fatalities = 0.003
    - Transportation related injuries or fatalities = 0.02

Heavy Truck Trips through Residential Areas

- None identified

Project: GSR Pilot for Shepley's Hill Landfill (Red Cove)
Option or Alternative: Baseline: Soil Bentonite Slurry Wall
Current Date: 4/10/2012

year	up-front cost	annual cost	present value of cost each year	cumulative cash flow	
		(no discounting)	2.7%	no discounting	2.7%
0	$1,210,292	$0	$1,210,292	$1,210,292	$1,210,292
1	$0	$5,000	$4,869	$1,215,292	$1,215,161
2	$0	$5,000	$4,741	$1,220,292	$1,219,901
3	$0	$5,000	$4,616	$1,225,292	$1,224,517
4	$0	$5,000	$4,495	$1,230,292	$1,229,012
5	$0	$5,000	$4,376	$1,235,292	$1,233,388
6	$0	$5,000	$4,261	$1,240,292	$1,237,649
7	$0	$5,000	$4,149	$1,245,292	$1,241,799
8	$0	$5,000	$4,040	$1,250,292	$1,245,839
9	$0	$5,000	$3,934	$1,255,292	$1,249,773
10	$0	$5,000	$3,831	$1,260,292	$1,253,604
11	$0	$5,000	$3,730	$1,265,292	$1,257,333
12	$0	$5,000	$3,632	$1,270,292	$1,260,965
13	$0	$5,000	$3,536	$1,275,292	$1,264,502
14	$0	$5,000	$3,443	$1,280,292	$1,267,945
15	$0	$5,000	$3,353	$1,285,292	$1,271,298
16	$0	$5,000	$3,265	$1,290,292	$1,274,562
17	$0	$5,000	$3,179	$1,295,292	$1,277,741
18	$0	$5,000	$3,095	$1,300,292	$1,280,837
19	$0	$5,000	$3,014	$1,305,292	$1,283,851
20	$0	$5,000	$2,935	$1,310,292	$1,286,785
21	$0	$5,000	$2,858	$1,315,292	$1,289,643
22	$0	$5,000	$2,782	$1,320,292	$1,292,425
23	$0	$5,000	$2,709	$1,325,292	$1,295,134
24	$0	$5,000	$2,638	$1,330,292	$1,297,772
25	$0	$5,000	$2,569	$1,335,292	$1,300,341
26	$0	$5,000	$2,501	$1,340,292	$1,302,842
27	$0	$5,000	$2,435	$1,345,292	$1,305,278
28	$0	$5,000	$2,371	$1,350,292	$1,307,649
29	$0	$5,000	$2,309	$1,355,292	$1,309,958
30	$0	$5,000	$2,248	$1,360,292	$1,312,206
31	$0	$5,000	$2,189	$1,365,292	$1,314,396
32	$0	$5,000	$2,132	$1,370,292	$1,316,527
33	$0	$5,000	$2,076	$1,375,292	$1,318,603
34	$0	$5,000	$2,021	$1,380,292	$1,320,624
35	$0	$5,000	$1,968	$1,385,292	$1,322,592
36	$0	$5,000	$1,916	$1,390,292	$1,324,508
37	$0	$5,000	$1,866	$1,395,292	$1,326,374
38	$0	$5,000	$1,817	$1,400,292	$1,328,190
39	$0	$5,000	$1,769	$1,405,292	$1,329,959
40	$0	$5,000	$1,722	$1,410,292	$1,331,682

Project: GSR Pilot for Shepley's Hill Landfill (Red Cove)
Option or Alternative: Baseline: Soil Bentonite Slurry Wall
Current Date: 4/10/2012

year	up-front cost	annual cost	present value of cost each year	cumulative cash flow	
		(no discounting)	2.7%	no discounting	2.7%
41	$0	$5,000	$1,677	$1,415,292	$1,333,359
42	$0	$5,000	$1,633	$1,420,292	$1,334,992
43	$0	$5,000	$1,590	$1,425,292	$1,336,582
44	$0	$5,000	$1,548	$1,430,292	$1,338,131
45	$0	$5,000	$1,508	$1,435,292	$1,339,638
46	$0	$5,000	$1,468	$1,440,292	$1,341,106
47	$0	$5,000	$1,429	$1,445,292	$1,342,536
48	$0	$5,000	$1,392	$1,450,292	$1,343,928
49	$0	$5,000	$1,355	$1,455,292	$1,345,283
50	$0	$5,000	$1,320	$1,460,292	$1,346,602
51	$0	$5,000	$1,285	$1,465,292	$1,347,887
52	$0	$5,000	$1,251	$1,470,292	$1,349,139
53	$0	$5,000	$1,218	$1,475,292	$1,350,357
54	$0	$5,000	$1,186	$1,480,292	$1,351,543
55	$0	$5,000	$1,155	$1,485,292	$1,352,698
56	$0	$5,000	$1,125	$1,490,292	$1,353,823
57	$0	$5,000	$1,095	$1,495,292	$1,354,918
58	$0	$5,000	$1,066	$1,500,292	$1,355,984
59	$0	$5,000	$1,038	$1,505,292	$1,357,022
60	$0	$5,000	$1,011	$1,510,292	$1,358,033
61	$0	$5,000	$984	$1,515,292	$1,359,018
62	$0	$5,000	$959	$1,520,292	$1,359,976
63	$0	$5,000	$933	$1,525,292	$1,360,910
64	$0	$5,000	$909	$1,530,292	$1,361,818
65	$0	$5,000	$885	$1,535,292	$1,362,703
66	$0	$5,000	$862	$1,540,292	$1,363,565
67	$0	$5,000	$839	$1,545,292	$1,364,404
68	$0	$5,000	$817	$1,550,292	$1,365,221
69	$0	$5,000	$795	$1,555,292	$1,366,016
70	$0	$5,000	$775	$1,560,292	$1,366,791
71	$0	$5,000	$754	$1,565,292	$1,367,545
72	$0	$5,000	$734	$1,570,292	$1,368,279
73	$0	$5,000	$715	$1,575,292	$1,368,994
74	$0	$5,000	$696	$1,580,292	$1,369,691
75	$0	$5,000	$678	$1,585,292	$1,370,369
76	$0	$5,000	$660	$1,590,292	$1,371,029
77	$0	$5,000	$643	$1,595,292	$1,371,671
78	$0	$5,000	$626	$1,600,292	$1,372,297
79	$0	$5,000	$609	$1,605,292	$1,372,907
80	$0	$5,000	$593	$1,610,292	$1,373,500
81	$0	$5,000	$578	$1,615,292	$1,374,078

Project: GSR Pilot for Shepley's Hill Landfill (Red Cove)
Option or Alternative: Baseline: Soil Bentonite Slurry Wall
Current Date: 4/10/2012

year	up-front cost	annual cost	present value of cost each year	cumulative cash flow	
		(no discounting)	2.7%	no discounting	2.7%
82	$0	$5,000	$563	$1,620,292	$1,374,640
83	$0	$5,000	$548	$1,625,292	$1,375,188
84	$0	$5,000	$533	$1,630,292	$1,375,722
85	$0	$5,000	$519	$1,635,292	$1,376,241
86	$0	$5,000	$506	$1,640,292	$1,376,747
87	$0	$5,000	$492	$1,645,292	$1,377,239
88	$0	$5,000	$479	$1,650,292	$1,377,719
89	$0	$5,000	$467	$1,655,292	$1,378,186
90	$0	$5,000	$455	$1,660,292	$1,378,640
91	$0	$5,000	$443	$1,665,292	$1,379,083
92	$0	$5,000	$431	$1,670,292	$1,379,514
93	$0	$5,000	$420	$1,675,292	$1,379,933
94	$0	$5,000	$409	$1,680,292	$1,380,342
95	$0	$5,000	$398	$1,685,292	$1,380,740
96	$0	$5,000	$387	$1,690,292	$1,381,127
97	$0	$5,000	$377	$1,695,292	$1,381,505
98	$0	$5,000	$367	$1,700,292	$1,381,872
99	$0	$5,000	$358	$1,705,292	$1,382,230
100	$0	$5,000	$348	$1,710,292	$1,382,578

Net Present Value (NPV)-> $1,382,578

*positive dollar value is a "cost", negative dollar value is a "savings"

GSR Team Calculations to Split Energy Results from SiteWise into "Direct" and "Indirect"
Soil Bentonite Slurry Wall (Baseline)

phase	Reported by SiteWise		Assigned by GSR Team from SiteWise Output			Total Calculated by GSR Team
			Scope 1 (direct)	Scope 2 (indirect)	Scope 3 (indirect)	
	activity	energy used (MMBTU)	energy used (MMBTU)	energy used (MMBTU)	energy used (MMBTU)	
Pre-Construction Investigation Activities – “Remedial Investigation” tab	Consumables	16.51	0.00	0.00	16.51	16.51
	Transportation-Personnel	17.41	0.00	0.00	17.41	17.41
	Transportation-Equipment	3.69	0.00	0.00	3.69	3.69
	Equipment Use and Misc	131.28	106.34	0.00	24.94	131.28
	Residual Handling	0.00	0.00	0.00	0.00	0.00
	Sub-Total	168.88	106.34	0.00	62.55	168.88
Pre-Construction Investigation Sampling – Uses “Remedial Action Construction” tab	Consumables	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	0.28	0.00	0.00	0.28	0.28
	Transportation-Equipment	6.58	0.00	0.00	6.58	6.58
	Equipment Use and Misc	0.00	0.00	0.00	0.00	0.00
	Residual Handling	0.00	0.00	0.00	0.00	0.00
	Sub-Total	6.86	0.00	0.00	6.86	6.86
Slurry Wall Construction – Uses “Remedial Action Operations” tab	Consumables	2956.14	0.00	0.00	2956.14	2956.14
	Transportation-Personnel	131.63	0.00	0.00	131.63	131.63
	Transportation-Equipment	263.87	0.00	0.00	263.87	263.87
	Equipment Use and Misc	2377.32	1925.63	0.00	451.69	2377.32
	Residual Handling	0.00	0.00	0.00	0.00	0.00
	Sub-Total	5728.96	1925.63	0.00	3803.33	5728.96
total		5904.70	2031.97	0.00	3872.74	5904.70

Note: Electricity use reported by SiteWise Version 2.0 in units of kWh is “Direct Scope 1”, meaning it is energy consumed at the location of the project. However, energy use associated with electricity reported by SiteWise in units of MMBtu is a life-cycle value which also includes a factor to account for energy used elsewhere required to generate the electricity (“Indirect Scope 2”). Here, 33% of the life-cycle value reported by SiteWise is considered to be "Scope 1" on-site energy use, and 67% is considered to be "Scope 2" energy used in electricity generation.

SiteWise Version 2.0 uses fuel energy values from U.S. Department of Energy, Argonne National Laboratory, Transportation Technology R&D Center, GREET 1.8d.1, Fuel-Cycle model, 2010. This version of the GREET model reports that for Gasoline and Diesel, approximately 19% of GHG emissions are upstream emissions (scope 3) and 81% are tailpipe emissions (scope 1). For this analysis, it is assumed that energy is used in these same proportions, and therefore the energy use reported by SiteWise is split between scope 3 and scope 1 in these ratios.

GSR Team Calculations to Split GHG Results from SiteWise into "Direct" and "Indirect"
Soil Bentonite Slurry Wall (Baseline)

phase	Reported by SiteWise: activity	Reported by SiteWise: GHG emitted (metric tons CO2e)	Assigned by GSR Team from SiteWise Output: Scope 1 (direct) GHG emitted (metric tons CO2e)	Assigned by GSR Team from SiteWise Output: Scope 2 (indirect) GHG emitted (metric tons CO2e)	Assigned by GSR Team from SiteWise Output: Scope 3 (indirect) GHG emitted (metric tons CO2e)	Total Calculated by GSR Team
Pre-Construction Investigation Activities – "Remedial Investigation" tab	Consumables	1.70	0.00	0.00	1.70	1.70
	Transportation-Personnel	1.37	0.00	0.00	1.37	1.37
	Transportation-Equipment	0.28	0.00	0.00	0.28	0.28
	Equipment Use and Misc	10.87	8.81	0.00	2.07	10.87
	Residual Handling	0.00	0.00	0.00	0.00	0.00
	Sub-Total	14.23	8.81	0.00	5.42	14.23
Pre-Construction Investigation Sampling – Uses "Remedial Action Construction" tab	Consumables	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	0.02	0.00	0.00	0.02	0.02
	Transportation-Equipment	0.48	0.00	0.00	0.48	0.48
	Equipment Use and Misc	0.00	0.00	0.00	0.00	0.00
	Residual Handling	0.00	0.00	0.00	0.00	0.00
	Sub-Total	0.50	0.00	0.00	0.50	0.50
Slurry Wall Construction – Uses "Remedial Action Operations" tab	Consumables	189.06	0.00	0.00	189.06	189.06
	Transportation-Personnel	10.44	0.00	0.00	10.44	10.44
	Transportation-Equipment	20.22	0.00	0.00	20.22	20.22
	Equipment Use and Misc	217.47	176.15	0.00	41.32	217.47
	Residual Handling	0.00	0.00	0.00	0.00	0.00
	Sub-Total	437.18	176.15	0.00	261.03	437.18
Total		451.91	184.96	0.00	266.95	451.91

Note: CO2e reported by SiteWise Version 2.0 for electricity use is all associated with generation of the electricity ("Indirect Scope 2").

SiteWise Version 2.0 use fuel emission factors from U.S. Department of Energy, Argonne National Laboratory, Transportation Technology R&D Center, GREET 1.8d.1, Fuel-Cycle model, 2010. This version of the GREET model reports that for gasoline and diesel, approximately 19% of GHG emissions are upstream emissions (Scope 3) and 81% are tailpipe emissions (Scope 1). For this analysis, the GHG emissions reported by SiteWise are split between Scope 3 and Scope 1 in these ratios.

Appendix C

Supporting Information and/or Calculations for Footprinting of Constructability Alternatives

Appendix C-1

Alternative 1 – Cement Bentonite (CB) Slurry Wall

Appendix C-1
Assumptions for SiteWise Input and Other Calculations
Shepley's Hill Landfill Pilot GSR Evaluation (Constructability Phase): Cement Bentonite (CB) Slurry Wall (Alternative 1)

SiteWise "RA_Alternative 1_NoFR_1" Directory

According to the *Shepley's Hill Landfill Pre-Construction Investigation Workplan* (dated November 2011) and the *Draft Constructability Basis Report, Hydraulic Barrier Wall at Shepley's Hill Landfill* (dated 21 October 2011), it is expected that the selected remedy for the site will include installation of a hydraulic barrier wall to the east of the existing landfill, between the landfill and Plow Shop Pond. The purpose of the barrier wall is to mitigate the flux of arsenic to Plow Shop Pond by diverting groundwater flow to the north. The barrier wall is intended to have a hydraulic conductivity of 1 x 10^{-7} cm/sec or less, and have a minimum design life of 100 years. The site consultant (AMEC) indicated in the *Draft Constructability Basis Report* that the soil bentonite (SB) slurry wall that was present as the "baseline" in Appendix B of this report is preferred versus other options. One of the alternative options includes a cement bentonite slurry wall. The GSR footprint of that alternative is presented here. Note the Project Team indicates that a CB slurry wall will generally only achieve 1 x 10^{-6} cm/sec, but a specific max may achieve 1 x 10^{-7} cm/sec (however, the volumes for that mixture are not known). The GSR Team assumes that approximately 1,300 cubic yards of cement will be required in place of 35% imported plastic fines/clay for the SB slurry wall in the baseline, which is estimated by the Project Team to require 1300 cubic yards of clay (Draft Constructability Basis Report, p.6)

For the purposes of footprinting, this alternative is assumed to involve the following components:

- A pre-construction constructability investigation
- Barrier wall construction
- Barrier wall O&M (minimal cost of $5,000 per year estimated in the FS, no other specific footprints calculated)

SiteWise inputs are based on the information described in the *Pre-Construction Investigation Workplan*, the *Draft Constructability Basis Report*, and data provided directly by the Project Team (in cases where the Project Team's values differed from what was indicated in the documents, the values provided by the Project Team were used). When information required for SiteWise input was not provided, reasonable assumptions were made (these assumptions are noted in the description of SiteWise input below). Note that the *Draft Constructability Basis Report* contains fewer details regarding the construction of the cement bentonite slurry wall and additional assumptions needed to be made based on the more detailed information provided for the soil bentonite slurry wall.

The notes pertaining to SiteWise input are organized by the following tabs of the SiteWise input sheet:

- Pre-Construction Investigation Activities – Uses *"Remedial Investigation"* tab of the SiteWise input sheet

Alternative 1 – Overview

- Pre-Construction Investigation Sampling– Uses *"Remedial Action Construction"* tab of SiteWise input sheet
- Slurry Wall Construction– Uses *"Remedial Action Operations"* tab of SiteWise input sheet

For each section of SiteWise, all the sections are listed, with pertinent information added only for those sections of the input sheet where data were added.

In some cases, small quantities of materials (such as locks for monitoring wells) were not included in SiteWise input because the footprint of these items relative to the other materials used would be expected to be extremely minimal.

Other calculations done outside of SiteWise are then presented. These include the following:

- % of total energy from renewable resources
- Hazardous air pollutants
- Refined material use
- Unrefined material use
- Tons of non-hazardous waste
- Tons of hazardous waste
- % of Potential Waste Recycled
- Risks to on-site works and from transportation
- Heavy truck trips through residential areas

Additional tables are attached which show how SiteWise outputs were split into "direct" and "indirect" energy use and greenhouse gas emissions. For definitions of direct and indirect energy use and emissions, please refer to section 2.2.2 of the evaluation report.

Cost calculations for the baseline remedy are based on cost information provided in the December 2010 Draft FFS (in which the barrier wall remedy was identified as "Alternative B: Containment Wall"), since no updated costs were included in the constructability work plan. The capital cost for this alternative was based on the constructability work plan, which indicated that cost for the cement bentonite slurry wall may be up to two times that of the soil bentonite slurry wall. The annual maintenance costs are assumed to be the same for all alternatives. A summary cost sheet developed by the GSR Team is attached to this Appendix. Information regarding the cost calculations is as follows:

- The capital cost is $2,420,584 and occurs in year 0.

- The annual operating cost is $5,000, occurring each year in years 1 through 100.

- The sum of capital and annual costs, non-discounted, is $2,920,584.

- To determine net present value (NPV), a 2.7 percent discount rate is applied to future costs, which is consistent with the discount rate applied in the Draft FFS. NPV is calculated by discounting future costs to present-day dollars using the following equation:

$$PV = \frac{FV}{(1+i)^n} = C \times FV$$

Alternative 1 – Overview

PV is the present value
FV is the value in year "n" (i.e., future value)
i is the discount rate
C is the discount factor, which equals $1/(1+i)^n$

- The NPV calculated by the GSR Team is $2,592,870.

Alternative 1 – Pre-Construction Investigation Activities

Scope of Work

Plans are to drill six exploratory borings (identified as SHM-11-01 through SHM-11-06), with SHM-11-02 completed as a bedrock well and SHM-11-06 completed as an overburden well. 10-foot rock core samples will be collected at each of these locations, with groundwater profiling for arsenic concentrations conducted at 10-foot sampling increments at locations SHM-11-02 and SHM-11-06.Additionally, two piezometers, identified as SHM-11-07 and SHM-11-08, will be installed to west of the proposed barrier wall location. The table below represents dimensions of boreholes and wells assumed by the GSR Team, based on descriptions in the site document *"Pre-Construction Investigation Workplan"*.

	SHM-11-01 boring	**SHM-11-02 MW-Bedrock**	**SHM-11-03 boring**	**SHM-11-04 boring**	**SHM-11-05 boring**	**SHM-11-06 MW - overburden**	**SHM-11-07 piezometer**	**SHM-11-08 piezometer**
depth (feet)*	50	65	25	50	30	50	30**	30**
well casing material	-	Outer casing of steel, bedrock portion open hole	-	-	-	PVC	PVC**	PVC **
casing diameter (in)	-	4**	-	-	-	2	2**	2**
borehole diameter (in)**	4	6	4	4	4	4	4	4
sand filter (ft)*	-	0	-	-	-	12.5*	7.5*	7.5*
Bentonite Seal (ft)*	-	0	-	-	-	2	2	2
Grouting (ft)*	50	10	25	50	30	27.5*	22.5*	22.5*
drilling method	drive and wash						hollow-stem auger (assumed)	
time (days)**	2	2	1	2	2	2	2	2

***Depths estimated based on site documents which indicate "40 to 65 feet" for well depth and "2-3 ft above screen" for filter pack**
****Assumed based on professional judgment of GSR team. For bedrock well assume outer steel casing will be 6 inch diameter**

The GSR Team assumes that 2 drillers will come from a distance of 50 miles one way (via light truck) and make one round trip per day, and assumes the drill rig will come from a distance of 50 miles one way and will be left on-site during drilling. The GSR Team assumes 1 on-site contractor will be present to supervise drilling, and will be traveling 20 miles one way, making one round trip per day.

The GSR Team assumed no significant footprint for the gate boxes or protective casings (i.e., well covers), and therefore did not include them in the SiteWise input.

The GSR Team is assuming the use of hollow stem auger for the drilling of all boreholes for footprinting (it is assumed that footprint would not be much different for drive and wash).

The GSR Team is assuming the use of an NxQ rock bore barrel for the collection and evaluation of the underlying bedrock. This activity is included as part of the drilling for footprinting purposes.

Alternative 1 – Pre-Construction Investigation Activities

The GSR Team is assuming the use of a 4-hour pump test and packer testing/rising head aquifer testing to evaluate bedrock hydraulic conductivity. This activity was considered negligible for footprinting.

The GSR Team is assuming the use of a geophysical survey to evaluate bedrock contour and depth along the path of the proposal barrier wall. This activity was considered negligible for footprinting.

Alternative 1 – Pre-Construction Investigation Activities

<u>Input into "Remedial Investigation" tab of SiteWise Input Sheet.xls</u>

- Baseline Information
  - Remedial Investigation Cost
    - Total remedial investigation cost ($) – leave blank in SiteWise

- Material Production
  - Well Materials
    - Well Type 1-Represents the PVC for screen and casing of the overburden monitoring well and the two piezometers. Three wells, assumed an average of 36.6 feet deep, PVC (assumed Schedule 40) and 2 inch casing diameter.
    - Well Type 2-Represents the steel outer casing for the bedrock monitoring well. One well, assumed an average of 65 feet deep, Steel (assumed Schedule 40) and assumed 4 inch casing diameter (the steel represents the outer casing through the overburden).
  - Treatment Chemicals & Materials
  - Treatment Media
  - Construction Materials
  - Well Decommissioning
  - Bulk Material Quantities
    - Material 1- Sand filter pack for overburden well and 2 piezometers. Select "sand" and "cubic feet". To calculate volume of sand, determine total volume within borehole ($V=\pi*(2/12)^2*$interval) and subtract volume within well casing ($V=\pi*(1/12)^2*$interval) for the interval where sand will be present. For the three wells, total interval height is 12.5 + 7.5+7.5 = 27.5 feet total. Total volume of sand calculated is 1.80 cubic feet.
    - Material 2-Bentonite Seal for overburden well and 2 piezometers. Select "Bentonite" and "cubic feet". To calculate volume of bentonite, determine total volume within borehole ($V=\pi*(2/12)^2*$interval) and subtract volume within well casing ($V=\pi*(1/12)^2*$interval) for the interval where bentonite will be present. For the three wells, total interval height is 2+2+2 = 6 feet. Total volume of bentonite calculated is 0.39 cubic feet.
    - Material 3-Grout for overburden well and 2 piezometers. Select "Typical cement" to represent grout. Select "cubic feet". To calculate volume of grout, determine total volume within borehole ($V=\pi*(2/12)^2*$interval) and subtract volume within well casing ($V=\pi*(1/12)^2*$interval) for the interval where grout will be present. For the three wells, total interval height is 27.5 + 22.5+ 22.5 = 72.5 feet. Total volume of grout calculated is 4.74 cubic feet.
    - Material 4-Grout for bedrock well. Select "Typical cement" to represent grout. Select "cubic feet". To calculate volume of grout, determine total volume within borehole ($V=\pi*(3/12)^2*$interval) and subtract volume within well casing ($V=\pi*(2/12)^2*$interval) for the interval where grout will be present of 10 feet. Total volume of grout calculated is 1.96 cubic feet.
    - Material 5-Grout for four other borings. Select "Typical cement" to represent grout. Select "cubic feet". To calculate volume of grout, determine total volume within borehole ($V=\pi*(3/12)^2*155$ (total length of SHM-11-01, SHM-11-03, SHM-11-04, and SHM-11-05). Total volume of grout calculated is 13.53 cubic feet

Alternative 1 – Pre-Construction Investigation Activities

- Transportation
  - Personnel Transportation – Road
    - Trip 1- Light truck for drillers. Select gasoline. Two drillers travelling from a distance of 100 miles round trip, one trip per day for sixteen days.
    - Trip 2- Heavy duty truck to represent drill rig. Select "diesel", 100 miles round trip, one round trip to bring rig to and from site (assume rig left on-site for length of drilling). Select "1" passenger.
    - Trip 3-On-site consultant. Select "light truck" and "gasoline". Travelling distance is assumed by GSR team to be 40 miles round trip, one trip per day for sixteen days. One passenger.
  - Personnel Transportation – Air
  - Personnel Transportation – Rail
  - Equipment Transportation – Road
    - Trip 1-Transport of well casing materials. Select "diesel" and 50 miles one way. Estimated total weight (from SiteWise output sheet) equals 79 lbs (PVC) plus 701 lbs (steel) = 780 lbs = 0.39 tons.
    - Trip 2-Transport of sand, bentonite and grout. Select "diesel" and 50 miles one way. Total weight of all sand, bentonite and grout were obtained from SiteWise output file and equals 94.3 kg (sand) + 19.9 kg (bentonite) + 202.1 kg (cement) + 83.6 kg (cement) + 577.0 kg (cement) = 976.9 kg = 2,149 lbs = 1.07 tons.
    - Trip 3- Return trip of both empty material delivery trucks. Select "diesel" and 100 miles (2 trucks travelling 50 miles one way). Total weight is zero tons.
  - Equipment Transportation – Air
  - Equipment Transportation – Rail
  - Equipment Transportation – Water

- Equipment Use
  - Earthwork
  - Drilling
    - Event 1- Drilling for eight boreholes. Select "Hollow Stem Auger" for drilling method. GSR team assumes an average of two days for each borehole, for 16 hours per location. Choose "diesel" for fuel type.
  - Trenching
  - Pump Operation
  - Diesel and Gasoline Pumps
  - Blower, Compressor, Mixer, and Other Equipment
  - Generators
  - Agricultural Equipment
  - Capping Equipment
  - Mixing Equipment
  - Internal Combustion Engines
  - Other Fueled Equipment
  - Operator Labor
  - Laboratory Analysis
  - Other Known Onsite Activities

- Residual Handling
  - Residue Disposal/Recycling

  - Landfill Operations
  - Thermal/Catalytic Oxidizers

- Resource Consumption
  - Water Consumption
  - Onsite Land and Water Resource Consumption

Once SiteWise input is complete, go to "SiteWise_Input Sheet " for overall project and enter information (including Alternative File Name "Baseline"). Then go to "Generate Alternative" tab and click button labeled "Click to generate alternative using previously entered alternative name". Copies of the input and output summary sheets for this alternative are now located in the directory titled "RA_Baseline _NoFR_1". To store the "Remedial Action Investigation.xls" calculation sheet showing detailed calculations, open it in the overall SiteWise project directory when the appropriate input sheet is open, then do a "save as" to put it in the directory for this alternative using a name that indicates "will not update". Then open that file and do "data->edit links" and break the links. If the input sheet for this alternative ever changes, then this calculation sheet needs to be re-saved.

To edit input parameters for this alternative, you must go back to the ORIGINAL SiteWise input sheet and import this alternative using the "Do you want to reload a previously saved remedial alternative in the SiteWise input sheet?" field on the "Site Info" tab. After making necessary changes to the input sheet, re-export the alternative by going to the "Generate Alternative" tab and clicking the button labeled "Click to replace an existing alternative with the same name". Update saved calculation sheets as described above.

Alternative 1 – Pre-Construction Investigation Sampling

<u>Scope of Work</u>

SHM-11-01 (Bore hole only)

- Split spoon (includes one geotechnical sample)
- Blow counts
- Rock cores

SHM-11-02 (Open hole Bedrock well with steel outer casing)

- Split spoons (includes one geotechnical sample)
- Blow counts
- Rock cores up to 15 ft into bedrock
- Rising head slug test/packer testing and 4-hour pump test
- Profiling samples at 10 ft intervals below the water table (submitted to lab and analyzed for As)
    - o GW will be purged using a stainless steel bladder pump or a peristaltic-inertial pump
- Groundwater sampled for TAL metals and ammonia using low flow
- Water elevations collected

SHM-11-03

- Split spoon (includes one geotechnical sample)
- Blow counts
- Rock cores

SHM-11-04 and SHM-11-05

- No split spoons, and blow counts only if there is significant variability for the first three boreholes
- One geotechnical sample if significant variability in subsurface conditions detected in SHM-11-01 through SHM-11-03.
- Rock cores

SHM-11-06 (Overburden monitoring well)

- No split spoons, and blow counts only if there is significant variability for the first three boreholes
- One geotechnical sample if significant variability in subsurface conditions detected in SHM-11-01 through SHM-11-03.
- Rock cores
- Groundwater sampled for TAL metals and ammonia using low flow
- Profiling samples at 10 ft intervals below the water table (submitted to lab and analyzed for As)
    - o GW will be purged using a stainless steel bladder pump or a peristaltic-inertial pump
- Water elevations collected

SHM-11-07 and SHM-11-08 (Piezometers)

- Soil samples and rock samples are not collected
- No blow counts collect
- Profiling samples at 10 ft intervals below the water table (submitted to lab and analyzed for As)
    - o GW will be purged using a stainless steel bladder pump or a peristaltic-inertial pump
- Water elevations collected

Alternative 1 – Pre-Construction Investigation Sampling

Transport of samples to laboratories:

- Assume ground courier to a groundwater lab, and separate courier to a geotechnical lab. Assume distance not to exceed 50 miles one way in each case. Assume that samples will account for approximately 50% of the courier's load.
- Assume all geotechnical samples in one shipment.
- Assume one groundwater sampling shipment for each well of 4 wells/piezometers to be profiled, plus 1 combined groundwater sampling shipment for the two wells to be sampled low-flow (i.e., 5 total shipments for groundwater sampling).

Alternative 1 – Pre-Construction Investigation Sampling

<u>Input into "Remedial Action Construction" tab of SiteWise Input Sheet.xls</u>

- Baseline Information
  - Remedial Action Construction Cost
    - Total remedial action construction cost ($) – leave blank in SiteWise

- Material Production
  - Well Materials
  - Treatment Chemicals & Materials
  - Treatment Media
  - Construction Materials
  - Well Decommissioning
  - Bulk Material Quantities

- Transportation
  - Personnel Transportation – Road
    - Trip 1-Represents the on-site consultant that performs low-flow sampling. Select "light truck" and "gasoline". GSR team assumed a 40 mile round trip distance, with 1 trip taken, with 1 traveler.
  - Personnel Transportation – Air
  - Personnel Transportation – Rail
  - Equipment Transportation – Road
    - Trip 1- Represent courier transport of geotechnical samples and rock cores. Select "gasoline". GSR team estimated trip to be a one way distance of 50 miles. Weight of rock cores and geotechnical samples were estimated by GSR team to be approximately 0.5 tons (rough estimate).
    - Trip 2-Represent courier transport of groundwater samples. Select "gasoline". Distance was calculated by assuming five separate trips of 50 miles each with site samples accounting for 50% of total courier load (5*50*0.5=125 miles). Assumed cooler weights to be 20 lbs. each (=0.01 tons).
    - Trip 3-Represents empty trips to pick up samples from site. Total distance equals sum of mileage for trips 1 and 2, above (50+125=175 miles). Enter "0" for weight.
  - Equipment Transportation – Air
  - Equipment Transportation – Rail
  - Equipment Transportation – Water

- Equipment Use
  - Earthwork
  - Drilling
  - Trenching
  - Pump Operation
  - Diesel and Gasoline Pumps
  - Blower, Compressor, Mixer, and Other Equipment
  - Generators
  - Agricultural Equipment
  - Capping Equipment
  - Mixing Equipment

    - Internal Combustion Engines
    - Other Fueled Equipment
    - Operator Labor
    - Laboratory Analysis
    - Other Known Onsite Activities

- Residual Handling
    - Residue Disposal/Recycling
    - Landfill Operations
    - Thermal/Catalytic Oxidizers

- Resource Consumption
    - Water Consumption
    - Onsite Land and Water Resource Consumption

Once SiteWise input is complete, go to "SiteWise_Input Sheet " for overall project and enter information (including Alternative File Name "Baseline"). Then go to "Generate Alternative" tab and click button labeled "Click to generate alternative using previously entered alternative name". Copies of the input and output summary sheets for this alternative are now located in the directory titled "RA_Baseline _NoFR_1". To store the "Remedial Action Construction.xls" calculation sheet showing detailed calculations, open it in the overall SiteWise project directory when the appropriate input sheet is open, then do a "save as" to put it in the directory for this alternative using a name that indicates "will not update". Then open that file and do "data->edit links" and break the links. If the input sheet for this alternative ever changes, then this calculation sheet needs to be re-saved.

To edit input parameters for this alternative, you must go back to the ORIGINAL SiteWise input sheet and import this alternative using the "Do you want to reload a previously saved remedial alternative in the SiteWise input sheet?" field on the "Site Info" tab. After making necessary changes to the input sheet, re-export the alternative by going to the "Generate Alternative" tab and clicking the button labeled "Click to replace an existing alternative with the same name". Update saved calculation sheets as described above.

Alternative 1 – Slurry Wall Construction

<u>*Scope of Work*</u>

- Barrier wall that is 800 to 950 feet long, 50 to 60 feet horizontal depth, 2.5 feet wide (*Draft Constructability Basis Report, p.6)*.
    - Materials
        - 400 tons of bentonite borrow for excavation of the trench and preparation of the backfill (*Draft Constructability Basis Report, p.6, based on SB wall)*
        - The GSR Team assumes that approximately 1,300 cubic yards of cement will be required. This is based on estimates for the SB slurry wall, which indicate that backfill for SB slurry wall will likely consist of excavated soils supplemented with 35% imported plastic fines/clay which is estimated by the Project Team to require 1300 cubic yards of clay (*Draft Constructability Basis Report, p.6)*
    - Transport of materials to site
        - Assume transport of any of the above materials would come from a distance no greater than 20 miles
    - Waste Disposal
        - Process will generate approximately 4500 to 5300 cubic yards of excess soil cuttings (*Draft Constructability Basis Report, p.6)* as well as 25-50 cubic yards of excess cement bentonite (CB) slurry and 50-75 cubic yards of bentonite water (BW) slurry that will require stabilization and disposal (*Draft Constructability Basis Report, p.6)*. Based on text in the *Draft Constructability Basis Report,* the GSR team assumes this will be deposited under the existing landfill cap on-site using machinery already mobilized to the site, and therefore no separate footprint is calculated for waste disposal and no landfill volume is calculated because this waste is not displacing any potential landfill space for other wastes such as would be the case if these items were placed in an off-site landfill.

- Transport of personnel to and from site
    - Specialty contractor for construction likely to come from Maryland, Pennsylvania or New Jersey (GSR Team assumes approximately 300 miles one-way from site). The GSR Team assumes 2 personnel from specialty contractor will be at the site for 7 weeks with 4 trips home. The GSR Team assumes 8 additional personnel (site contractors and equipment operators) will be local from within 30 miles of the site on average. The GSR Team assumes specialty personnel stay at hotel within 5 miles of site.

- Landfill cap
    - Expansion of the existing landfill cap between the barrier and the landfill to minimize infiltration in that area (*Draft Constructability Basis Report* , p.5) appears minimal, estimated by the GSR Team to be ~3,750 square feet based on maps)
    - Materials
        - 300 ml polyvinylchloride (PVC) membrane cap (*Draft Constructability Basis Report* , p.2)
        - Soil and vegetation cover (assumed by GSR team to require imported clean fill for depth of 2 ft)
- Platform
    - Materials
        - Will need to import 2,400 to 2,800 cubic yards of sand/gravel borrow (*Draft Constructability Basis Report*, p.5). The GSR Team will assume 2,600 cubic yards.

Alternative 1 – Slurry Wall Construction

- Equipment use
  - Equipment (*Draft Constructability Basis Report, p.8)*
    - CAT 365/Komatsu PC-1250 excavator (bucket width 2-3 feet)
    - Long reach trenching attachment (not available locally)
    - CAT 950 front end loader, or similar
    - AT325 excavator, or similar
    - CAT D5, or similar- used to mix slurry adjacent to the trench and place mixed backfill into trench
    - Slurry mixing plant
    - (3-4) 20, 000 gallon slurry tanks
    - Slurry pumps, hoses and piping
    - 100kW generator, assuming that no commercial power is available
  - The Project Team estimates that total fuel consumption is estimated to be approximately 500 gallons of diesel per day for 6-8 weeks (*Draft Constructability Basis Report, p.8.* Unless otherwise noted, the GSR Team assumes this fuel consumption will account for all equipment usage noted above. The GSR Team informally reviewed this fuel usage estimate and considers it to be reasonable.
  - Transport of equipment to and from site
    - Assume the slurry mixing plant coming from specialty contractor, assumed to be 300 miles away (one way)
    - Assume transport of the rest of the equipment (and fuel for that equipment) would come from a distance no greater than 50 miles one way
- Water consumption
  - Approximately 100,000 gallons "per shift" (*Draft Constructability Basis Report, p.8*). Each shift is ~8-hours based on the 200 gpm estimate provided in the *Draft Constructability Basis Report*
  - Based on the *Draft Constructability Basis Report (p.8*), water sources may include a local hydrant (assumed to represent potable water) and/or water from the pond (assumed to represent non-potable water) or treated water from the treatment plant (which otherwise goes to the POTW and is assumed to represent non-potable water). The GSR Team assumes for the baseline alternative utilizes potable water from the hydrant.

Alternative 1 – Slurry Wall Construction

<u>Input into "Remedial Action Operations" tab of SiteWise Input Sheet.xls</u>

- Baseline Information
    - Remedial Action Operations Cost and Duration
        - Total remedial action operations cost ($) – leave blank in SiteWise
        - Duration of remedial action operations (unit time) – 1 yr for this GSR evaluation because we have multiplied input items by number of years as part of the input

- Material Production
    - Well Materials
    - Treatment Chemicals & Materials
    - Treatment Media
    - Construction Materials
    - Well Decommissioning
    - Bulk Material Quantities
        - Material 1- Bentonite borrow for excavation of trench and preparation of backfill. Select "Bentonite", pounds, and 400 tons * 2000 pounds per ton=800,000.
        - Material 2- Cement for CB construction. Select "Typical Cement", cubic feet, and 1300 cubic yards *27 cubic feet per cubic yard=35,100 cubic feet.
        - Material 3-Sand/gravel borrow for working platform for slurry wall construction-Select Gravel to represent sand/gravel borrow, unit is cubic feet, input material quantity is assumed to be the average of 2400 to 2800=2,600 cubic yards, cubic feet of material=2600*27=70,200 cubic feet
        - Material 4-PVC liner for extension of landfill cap, in pounds, with 30 mil PVC=0.2 lbs per square foot (internet research), and estimated addition to cap (from maps) 3,750 square feet=0.2*3,750=750 pounds.
        - Material 5- Soil to cover PVC liner for extension of landfill cap. Select "cubic feet". Soil estimated to be 2 feet thick over 3,750 square feet extension=7,500 cubic feet.
- Transportation
    - Personnel Transportation – Road
        - Trip 1-Slurry wall specialty contractor traveling from out of state. Assume cars, gasoline, 600 miles round trip (average distance from places that contractors are expected to come from), assume 4 round trips over the 7 weeks to site for 1 vehicle, 2 passengers per vehicle.
        - Trip 2-Slurry wall contractor traveling from hotel and out for lunch. Assume cars, gasoline, 10 miles round trip (average distance from nearby hotels), assume two round trips to site per day for 5 days per week for 7 weeks, for 1 vehicle, 2 passengers per vehicle.
        - Trip 3-Local Project team consultant and operators traveling from home to site for work. Assume a light truck, gasoline, 60 mile round trip, 8 trips per day for 5 days per week for 7 weeks, 1 traveler per vehicle.
    - Personnel Transportation – Air
    - Personnel Transportation – Rail
    - Equipment Transportation – Road
        - Trip 1-Transport of all equipment (and associated fuel) listed in Scope of Work to and from site except slurry mixing plant. Select diesel, distance traveled is

assumed to be 100 miles round trip for 10 vehicles, each carrying 20 tons of equipment (the number of vehicles and tons is a rough estimate by the GSR Team, no detailed analysis was performed).
        - Trip 2-Return trip for empty vehicles in Trip 1, Select diesel, 10 vehicles traveling 100 miles round trip carrying 0 tons of weight.
        - Trip 3- Transport of Bentonite, cement, sand/gravel borrow, PVC liner and soil for cap, equal to total of 6156 tons, (obtained from SiteWise output file). Select diesel, and input the total distance as 3,080 miles (assuming each vehicle will hold 40 tons, this will require approximately 154 vehicles and assume each trip is 20 miles one way.
        - Trip 4-Return trip for vehicles that transported above materials in Trip 3. The total distance is 3,080 miles from 154 vehicles going 20 miles, one way. Each vehicle will hold 0 tons.
        - Trip 5 - Transport of slurry mixing plant. Select diesel, distance traveled is assumed to be 600 miles round trip for 1 vehicle, carrying 20 tons of equipment (the number of vehicles and tons is a rough estimate by the GSR Team, no detailed analysis was performed).
        - Trip 6 – Return trip for vehicles that transported slurry mixing plant in Trip 5. The total distance is 600 miles from 1 vehicles going 600 miles round trip. Each vehicle will hold 0 tons.

    - Equipment Transportation – Air
    - Equipment Transportation – Rail
    - Equipment Transportation – Water

- Equipment Use
    - Earthwork
    - Drilling
    - Trenching
    - Pump Operation
    - Diesel and Gasoline Pumps
    - Blower, Compressor, Mixer, and Other Equipment
    - Generators
    - Agricultural Equipment
    - Capping Equipment
    - Mixing Equipment
    - Internal Combustion Engines
        - Engine 1-Representing total fuel consumption for all fuel use in Scope of Work (approximately 500 gallons per day for seven weeks), Select diesel, input fuel consumption=(500/8)=62.5 gallons per hr, and input operating hours=8 hrs/d* 5 days per week*7 weeks =280 hours.
    - Other Fueled Equipment
    - Operator Labor
    - Laboratory Analysis
    - Other Known Onsite Activities
        - Water consumption (gallon)- represents all water required for construction to include local hydrant and/or water from pond or treated water from the

treatment plant, unknown distribution. Total use=100,000 gal per day*5 days per week*7 weeks=3,500,000 gallons

- Residual Handling
  - Residue Disposal/Recycling
  - Landfill Operations
  - Thermal/Catalytic Oxidizers

- Resource Consumption
  - Water Consumption
  - Onsite Land and Water Resource Consumption

Once SiteWise input is complete, go to "SiteWise_Input Sheet " for overall project and enter information (including Alternative File Name "Baseline"). Then go to "Generate Alternative" tab and click button labeled "Click to generate alternative using previously entered alternative name". Copies of the input and output summary sheets for this alternative are now located in the directory titled "RA_Baseline _NoFR_1". To store the "Remedial Action Operations.xls" calculation sheet showing detailed calculations, open it in the overall SiteWise project directory when the appropriate input sheet is open, then do a "save as" to put it in the directory for this alternative using a name that indicates "will not update". Then open that file and do "data->edit links" and break the links. If the input sheet for this alternative ever changes, then this calculation sheet needs to be re-saved.

To edit input parameters for this alternative, you must go back to the ORIGINAL SiteWise input sheet and import this alternative using the "Do you want to reload a previously saved remedial alternative in the SiteWise input sheet?" field on the "Site Info" tab. After making necessary changes to the input sheet, re-export the alternative by going to the "Generate Alternative" tab and clicking the button labeled "Click to replace an existing alternative with the same name". Update saved calculation sheets as described above.

Other Supporting Calculations: Cement Bentonite (CB) Slurry Wall (Alternative 1)

% of Total Energy Usage from Renewable Resources

- None identified (since remedy construction will not require electricity use)

Hazardous Air Pollutants

- None identified

.

Refined Materials Use

Material	Lbs	Basis
PVC (well casing)	79	Calculated by SiteWise output file
Steel (well casing)	701	Calculated by SiteWise output file
Cement (grout for overburden well and 2 piezometers)	444.7	Calculated by SiteWise output file
Cement (grout for bedrock well)	183.9	Calculated by SiteWise output file
Cement (grout for other borings)	1,269.2	Calculated by SiteWise output file
Cement (for slurry wall material)	3,293,060.5	Calculated by SiteWise output file
PVC (liner for cap extension)	750	Calculated by GSR Team
Total	***3,296,488.3 lbs***	

Unrefined Materials Use

Material	Tons	Basis
Bentonite (seal on wells)	0.1	Calculated by SiteWise output file
Sand (filter packs)	0.1	Calculated by SiteWise output file
Bentonite (borrow for trench)	400	Calculated by GSR Team
Sand/gravel (borrow for platform)	3,677.9	Calculated by SiteWise output file
Soil (cover for cap extension)	432.2	Calculated by SiteWise output file
Total	***4,510.3 tons***	

Tons of Non-Hazardous Waste

- None identified (will be placed under existing cap with equipment already mobilized to the site)

Tons of Hazardous Waste

- None identified

Alternative 1– Other Supporting Calculations

% of Potential Waste Recycled

- N/A

Risks to On-Site Workers and from Transportation

- Based on SiteWise output
  - On-Site worker injuries or fatalities = 0.003
  - Transportation related injuries or fatalities = 0.02

Heavy Truck Trips through Residential Areas

- None identified

Project: GSR Pilot for Shepley's Hill Landfill (Red Cove)
Option or Alternative: Alternative 1: Cement Bentonite Slurry Wall
Current Date: 4/10/2012

year	up-front cost	annual cost		present value of cost each year		cumulative cash flow	
		(no discounting)		2.7%		no discounting	2.7%
0	$2,420,584	$0		$2,420,584		$2,420,584	$2,420,584
1	$0	$5,000		$4,869		$2,425,584	$2,425,453
2	$0	$5,000		$4,741		$2,430,584	$2,430,193
3	$0	$5,000		$4,616		$2,435,584	$2,434,809
4	$0	$5,000		$4,495		$2,440,584	$2,439,304
5	$0	$5,000		$4,376		$2,445,584	$2,443,680
6	$0	$5,000		$4,261		$2,450,584	$2,447,941
7	$0	$5,000		$4,149		$2,455,584	$2,452,091
8	$0	$5,000		$4,040		$2,460,584	$2,456,131
9	$0	$5,000		$3,934		$2,465,584	$2,460,065
10	$0	$5,000		$3,831		$2,470,584	$2,463,896
11	$0	$5,000		$3,730		$2,475,584	$2,467,625
12	$0	$5,000		$3,632		$2,480,584	$2,471,257
13	$0	$5,000		$3,536		$2,485,584	$2,474,794
14	$0	$5,000		$3,443		$2,490,584	$2,478,237
15	$0	$5,000		$3,353		$2,495,584	$2,481,590
16	$0	$5,000		$3,265		$2,500,584	$2,484,854
17	$0	$5,000		$3,179		$2,505,584	$2,488,033
18	$0	$5,000		$3,095		$2,510,584	$2,491,129
19	$0	$5,000		$3,014		$2,515,584	$2,494,143
20	$0	$5,000		$2,935		$2,520,584	$2,497,077
21	$0	$5,000		$2,858		$2,525,584	$2,499,935
22	$0	$5,000		$2,782		$2,530,584	$2,502,717
23	$0	$5,000		$2,709		$2,535,584	$2,505,426
24	$0	$5,000		$2,638		$2,540,584	$2,508,064
25	$0	$5,000		$2,569		$2,545,584	$2,510,633
26	$0	$5,000		$2,501		$2,550,584	$2,513,134
27	$0	$5,000		$2,435		$2,555,584	$2,515,570
28	$0	$5,000		$2,371		$2,560,584	$2,517,941
29	$0	$5,000		$2,309		$2,565,584	$2,520,250
30	$0	$5,000		$2,248		$2,570,584	$2,522,498
31	$0	$5,000		$2,189		$2,575,584	$2,524,688
32	$0	$5,000		$2,132		$2,580,584	$2,526,819
33	$0	$5,000		$2,076		$2,585,584	$2,528,895
34	$0	$5,000		$2,021		$2,590,584	$2,530,916
35	$0	$5,000		$1,968		$2,595,584	$2,532,884
36	$0	$5,000		$1,916		$2,600,584	$2,534,800
37	$0	$5,000		$1,866		$2,605,584	$2,536,666
38	$0	$5,000		$1,817		$2,610,584	$2,538,482
39	$0	$5,000		$1,769		$2,615,584	$2,540,251
40	$0	$5,000		$1,722		$2,620,584	$2,541,974

Project: GSR Pilot for Shepley's Hill Landfill (Red Cove)
Option or Alternative: Alternative 1: Cement Bentonite Slurry Wall
Current Date: 4/10/2012

year	up-front cost	annual cost	present value of cost each year	cumulative cash flow	
		(no discounting)	2.7%	no discounting	2.7%
41	$0	$5,000	$1,677	$2,625,584	$2,543,651
42	$0	$5,000	$1,633	$2,630,584	$2,545,284
43	$0	$5,000	$1,590	$2,635,584	$2,546,874
44	$0	$5,000	$1,548	$2,640,584	$2,548,423
45	$0	$5,000	$1,508	$2,645,584	$2,549,930
46	$0	$5,000	$1,468	$2,650,584	$2,551,398
47	$0	$5,000	$1,429	$2,655,584	$2,552,828
48	$0	$5,000	$1,392	$2,660,584	$2,554,220
49	$0	$5,000	$1,355	$2,665,584	$2,555,575
50	$0	$5,000	$1,320	$2,670,584	$2,556,894
51	$0	$5,000	$1,285	$2,675,584	$2,558,179
52	$0	$5,000	$1,251	$2,680,584	$2,559,431
53	$0	$5,000	$1,218	$2,685,584	$2,560,649
54	$0	$5,000	$1,186	$2,690,584	$2,561,835
55	$0	$5,000	$1,155	$2,695,584	$2,562,990
56	$0	$5,000	$1,125	$2,700,584	$2,564,115
57	$0	$5,000	$1,095	$2,705,584	$2,565,210
58	$0	$5,000	$1,066	$2,710,584	$2,566,276
59	$0	$5,000	$1,038	$2,715,584	$2,567,314
60	$0	$5,000	$1,011	$2,720,584	$2,568,325
61	$0	$5,000	$984	$2,725,584	$2,569,310
62	$0	$5,000	$959	$2,730,584	$2,570,268
63	$0	$5,000	$933	$2,735,584	$2,571,202
64	$0	$5,000	$909	$2,740,584	$2,572,110
65	$0	$5,000	$885	$2,745,584	$2,572,995
66	$0	$5,000	$862	$2,750,584	$2,573,857
67	$0	$5,000	$839	$2,755,584	$2,574,696
68	$0	$5,000	$817	$2,760,584	$2,575,513
69	$0	$5,000	$795	$2,765,584	$2,576,308
70	$0	$5,000	$775	$2,770,584	$2,577,083
71	$0	$5,000	$754	$2,775,584	$2,577,837
72	$0	$5,000	$734	$2,780,584	$2,578,571
73	$0	$5,000	$715	$2,785,584	$2,579,286
74	$0	$5,000	$696	$2,790,584	$2,579,983
75	$0	$5,000	$678	$2,795,584	$2,580,661
76	$0	$5,000	$660	$2,800,584	$2,581,321
77	$0	$5,000	$643	$2,805,584	$2,581,963
78	$0	$5,000	$626	$2,810,584	$2,582,589
79	$0	$5,000	$609	$2,815,584	$2,583,199
80	$0	$5,000	$593	$2,820,584	$2,583,792
81	$0	$5,000	$578	$2,825,584	$2,584,370

Project: GSR Pilot for Shepley's Hill Landfill (Red Cove)
Option or Alternative: Alternative 1: Cement Bentonite Slurry Wall
Current Date: 4/10/2012

year	up-front cost	annual cost		present value of cost each year		cumulative cash flow	
		(no discounting)		2.7%		no discounting	2.7%
82	$0	$5,000		$563		$2,830,584	$2,584,932
83	$0	$5,000		$548		$2,835,584	$2,585,480
84	$0	$5,000		$533		$2,840,584	$2,586,014
85	$0	$5,000		$519		$2,845,584	$2,586,533
86	$0	$5,000		$506		$2,850,584	$2,587,039
87	$0	$5,000		$492		$2,855,584	$2,587,531
88	$0	$5,000		$479		$2,860,584	$2,588,011
89	$0	$5,000		$467		$2,865,584	$2,588,478
90	$0	$5,000		$455		$2,870,584	$2,588,932
91	$0	$5,000		$443		$2,875,584	$2,589,375
92	$0	$5,000		$431		$2,880,584	$2,589,806
93	$0	$5,000		$420		$2,885,584	$2,590,225
94	$0	$5,000		$409		$2,890,584	$2,590,634
95	$0	$5,000		$398		$2,895,584	$2,591,032
96	$0	$5,000		$387		$2,900,584	$2,591,419
97	$0	$5,000		$377		$2,905,584	$2,591,797
98	$0	$5,000		$367		$2,910,584	$2,592,164
99	$0	$5,000		$358		$2,915,584	$2,592,522
100	$0	$5,000		$348		$2,920,584	$2,592,870

Net Present Value (NPV)-> $2,592,870

*positive dollar value is a "cost", negative dollar value is a "savings"

GSR Team Calculations to Split Energy Results from SiteWise into "Direct" and "Indirect"
Cement Bentonite Slurry Wall (Alternative 1)

phase	Reported by SiteWise: activity	Reported by SiteWise: energy used (MMBTU)	Assigned by GSR Team from SiteWise Output: Scope 1 (direct) energy used (MMBTU)	Scope 2 (indirect) energy used (MMBTU)	Scope 3 (indirect) energy used (MMBTU)	Total Calculated by GSR Team
Pre-Construction Investigation Activities – "Remedial Investigation" tab	Consumables	16.51	0.00	0.00	16.51	16.51
	Transportation-Personnel	17.41	0.00	0.00	17.41	17.41
	Transportation-Equipment	3.69	0.00	0.00	3.69	3.69
	Equipment Use and Misc	131.28	106.34	0.00	24.94	131.28
	Residual Handling	0.00	0.00	0.00	0.00	0.00
	Sub-Total	168.88	106.34	0.00	62.55	168.88
Pre-Construction Investigation Sampling – Uses "Remedial Action Construction" tab	Consumables	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	0.28	0.00	0.00	0.28	0.28
	Transportation-Equipment	6.58	0.00	0.00	6.58	6.58
	Equipment Use and Misc	0.00	0.00	0.00	0.00	0.00
	Residual Handling	0.00	0.00	0.00	0.00	0.00
	Sub-Total	6.86	0.00	0.00	6.86	6.86
Slurry Wall Construction – Uses "Remedial Action Operations" tab	Consumables	8698.06	0.00	0.00	8698.06	8698.06
	Transportation-Personnel	131.63	0.00	0.00	131.63	131.63
	Transportation-Equipment	253.16	0.00	0.00	253.16	253.16
	Equipment Use and Misc	2377.32	1925.63	0.00	451.69	2377.32
	Residual Handling	0.00	0.00	0.00	0.00	0.00
	Sub-Total	11460.18	1925.63	0.00	9534.55	11460.18
total		11635.92	2031.97	0.00	9603.95	11635.92

Note: *Electricity use reported by SiteWise Version 2.0 in units of kWh is "Direct Scope 1", meaning it is energy consumed at the location of the project. However, energy use associated with electricity reported by SiteWise in units of MMBtu is a life-cycle value which also includes a factor to account for energy used elsewhere required to generate the electricity ("Indirect Scope 2"). Here, 33% of the life-cycle value reported by SiteWise is considered to be "Scope 1" on-site energy use, and 67% is considered to be "Scope 2" energy used in electricity generation.*

SiteWise Version 2.0 uses fuel energy values from U.S. Department of Energy, Argonne National Laboratory, Transportation Technology R&D Center, GREET 1.8d.1, Fuel-Cycle model, 2010. This version of the GREET model reports that for Gasoline and Diesel, approximately 19% of GHG emissions are upstream emissions (scope 3) and 81% are tailpipe emissions (scope 1). For this analysis, it is assumed that energy is used in these same proportions, and therefore the energy use reported by SiteWise is split between scope 3 and scope 1 in these ratios.

GSR Team Calculations to Split GHG Results from SiteWise into "Direct" and "Indirect"
Cement Bentonite Slurry Wall (Alternative 1)

phase	Reported by SiteWise: activity	Reported by SiteWise: GHG emitted (metric tons CO2e)	Assigned by GSR Team from SiteWise Output: Scope 1 (direct) GHG emitted (metric tons CO2e)	Scope 2 (indirect) GHG emitted (metric tons CO2e)	Scope 3 (indirect) GHG emitted (metric tons CO2e)	Total Calculated by GSR Team
Pre-Construction Investigation Activities – "Remedial Investigation" tab	Consumables	1.70	0.00	0.00	1.70	1.70
	Transportation-Personnel	1.37	0.00	0.00	1.37	1.37
	Transportation-Equipment	0.28	0.00	0.00	0.28	0.28
	Equipment Use and Misc	10.87	8.81	0.00	2.07	10.87
	Residual Handling	0.00	0.00	0.00	0.00	0.00
	Sub-Total	14.23	8.81	0.00	5.42	14.23
Pre-Construction Investigation Sampling – Uses "Remedial Action Construction" tab	Consumables	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	0.02	0.00	0.00	0.02	0.02
	Transportation-Equipment	0.48	0.00	0.00	0.48	0.48
	Equipment Use and Misc	0.00	0.00	0.00	0.00	0.00
	Residual Handling	0.00	0.00	0.00	0.00	0.00
	Sub-Total	0.50	0.00	0.00	0.50	0.50
Slurry Wall Construction – Uses "Remedial Action Operations" tab	Consumables	1389.15	0.00	0.00	1389.15	1389.15
	Transportation-Personnel	10.44	0.00	0.00	10.44	10.44
	Transportation-Equipment	19.40	0.00	0.00	19.40	19.40
	Equipment Use and Misc	217.47	176.15	0.00	41.32	217.47
	Residual Handling	0.00	0.00	0.00	0.00	0.00
	Sub-Total	1636.45	176.15	0.00	1460.30	1636.45
Total		1651.19	184.96	0.00	1466.22	1651.19

Note: CO2e reported by SiteWise Version 2.0 for electricity use is all associated with generation of the electricity ("Indirect Scope 2").

SiteWise Version 2.0 use fuel emission factors from U.S. Department of Energy, Argonne National Laboratory, Transportation Technology R&D Center, GREET 1.8d.1, Fuel-Cycle model, 2010. This version of the GREET model reports that for gasoline and diesel, approximately 19% of GHG emissions are upstream emissions (Scope 3) and 81% are tailpipe emissions (Scope 1). For this analysis, the GHG emissions reported by SiteWise are split between Scope 3 and Scope 1 in these ratios.

Appendix C-2

Alternative 2 – Grouted Sheet Pile Wall

Appendix C-2
Assumptions for SiteWise Input and Other Calculations
Shepley's Hill Landfill Pilot GSR Evaluation (Construcatbility Phase): Grouted Sheet Pile Wall (Alternative 2)

SiteWise "RA_Alternative 2_NoFR_1" Directory

According to the *Shepley's Hill Landfill Pre-Construction Investigation Workplan* (dated November 2011) and the *Draft Constructability Basis Report, Hydraulic Barrier Wall at Shepley's Hill Landfill* (dated 21 October 2011 it is expected that the selected remedy for the site will include installation of a hydraulic barrier wall to the east of the existing landfill, between the landfill and Plow Shop Pond. The purpose of the barrier wall is to mitigate the flux of arsenic to Plow Shop Pond by diverting groundwater flow to the north. The barrier wall is intended to have a hydraulic conductivity of 1×10^{-7} cm/sec or less, and have a minimum design life of 100 years. The site consultant (AMEC) indicated in the *Draft Constructability Basis Report* that the soil bentonite (SB) slurry wall that was present as the "baseline" in Appendix B of this report is preferred versus other options. One of the alternative options includes a grouted sheet pile wall. The GSR footprint of that alternative is presented here.

For the purposes of footprinting, this alternative is assumed to involve the following components:

- A pre-construction constructability investigation
- Barrier wall construction
- Barrier wall O&M (minimal cost of $5,000 per year estimated in the FS, no other specific footprints calculated)

SiteWise inputs are based on the information described in the *Pre-Construction Investigation Workplan*, the *Draft Constructability Basis Report*, and data provided directly by the Project Team (in cases where the Project Team's values differed from what was indicated in the documents, the values provided by the Project Team were used). When information required for SiteWise input was not provided, reasonable assumptions were made (these assumptions are noted in the description of SiteWise input below). Note that the *Draft Constructability Basis Report* contains fewer details regarding the construction of the grouted sheet pile wall versus the more detailed information provided for the soil bentonite slurry wall, so the GSR Team had to make some assumptions (discussed below).

The notes pertaining to SiteWise input are organized by the following tabs of the SiteWise input sheet:

- Pre-Construction Investigation Activities – Uses *"Remedial Investigation"* tab of the SiteWise input sheet
- Pre-Construction Investigation Sampling– Uses *"Remedial Action Construction"* tab of SiteWise input sheet
- Grouted Sheet Pile Wall Construction– Uses *"Remedial Action Operations"* tab of SiteWise input sheet

Alternative 2 – Overview

For each section of SiteWise, all the sections are listed, with pertinent information added only for those sections of the input sheet where data were added.

In some cases, small quantities of materials (such as locks for monitoring wells) were not included in SiteWise input because the footprint of these items relative to the other materials used would be expected to be extremely minimal.

Other calculations done outside of SiteWise are then presented. These include the following:

- % of total energy from renewable resources
- Hazardous air pollutants
- Refined material use
- Unrefined material use
- Tons of non-hazardous waste
- Tons of hazardous waste
- % of Potential Waste Recycled
- Risks to on-site works and from transportation
- Heavy truck trips through residential areas

Additional tables are attached which show how SiteWise outputs were split into "direct" and "indirect" energy use and greenhouse gas emissions. For definitions of direct and indirect energy use and emissions, please refer to section 2.2.2 of the evaluation report.

Cost calculations for the baseline remedy are based on cost information provided in the December 2010 Draft FFS (in which the barrier wall remedy was identified as "Alternative B: Containment Wall"), since no updated costs were included in the constructability work plan. The capital cost for this alternative was based on the constructability work plan, which indicated that cost for the grouted sheet pile wall may be three to four times that of the soil bentonite slurry wall. The annual maintenance costs are assumed to be the same for all alternatives. A summary cost sheet developed by the GSR Team is attached to this Appendix. Information regarding the cost calculations is as follows:

- The capital cost is $3,630,876 and occurs in year 0.

- The annual operating cost is $5,000, occurring each year in years 1 through 100.

- The sum of capital and annual costs, non-discounted, is $4,130,876.

- To determine net present value (NPV), a 2.7 percent discount rate is applied to future costs, which is consistent with the discount rate applied in the Draft FFS. NPV is calculated by discounting future costs to present-day dollars using the following equation:

$$PV = \frac{FV}{(1+i)^n} = C \times FV$$

PV is the present value
FV is the value in year "n" (i.e., future value)
i is the discount rate
C is the discount factor, which equals $1/(1+i)^n$

Alternative 2 – Overview

- The NPV calculated by the GSR Team is $3,803,162.

Alternative 2– Pre-Design Investigation Activities

Scope of Work

Plans are to drill six exploratory borings (identified as SHM-11-01 through SHM-11-06), with SHM-11-02 completed as a bedrock well and SHM-11-06 completed as an overburden well. 10-foot rock core samples will be collected at each of these locations, with groundwater profiling for arsenic concentrations conducted at 10-foot sampling increments at locations SHM-11-02 and SHM-11-06.Additionally, two piezometers, identified as SHM-11-07 and SHM-11-08, will be installed to west of the proposed barrier wall location. The table below represents dimensions of boreholes and wells assumed by the GSR Team, based on descriptions in the site document *"Pre-Construction Investigation Workplan"*.

	SHM-11-01 boring	**SHM-11-02 MW-Bedrock**	**SHM-11-03 boring**	**SHM-11-04 boring**	**SHM-11-05 boring**	**SHM-11-06 MW - overburden**	**SHM-11-07 piezometer**	**SHM-11-08 piezometer**
depth (feet)*	50	65	25	50	30	50	30**	30**
well casing material	-	Outer casing of steel, bedrock portion open hole	-	-	-	PVC	PVC**	PVC **
casing diameter (in)	-	4**	-	-	-	2	2**	2**
borehole diameter (in)**	4	6	4	4	4	4	4	4
sand filter (ft)*	-	0	-	-	-	12.5*	7.5*	7.5*
Bentonite Seal (ft)*	-	0	-	-	-	2	2	2
Grouting (ft)*	50	10	25	50	30	27.5*	22.5*	22.5*
drilling method	drive and wash						hollow-stem auger (assumed)	
time (days)**	2	2	1	2	2	2	2	2

***Depths estimated based on site documents which indicate "40 to 65 feet" for well depth and "2-3 ft above screen" for filter pack**
****Assumed based on professional judgment of GSR team. For bedrock well assume outer steel casing will be 6 inch diameter**

The GSR Team assumes that 2 drillers will come from a distance of 50 miles one way (via light truck) and make one round trip per day, and assumes the drill rig will come from a distance of 50 miles one way and will be left on-site during drilling. The GSR Team assumes 1 on-site contractor will be present to supervise drilling, and will be traveling 20 miles one way, making one round trip per day.

The GSR Team assumed no significant footprint for the gate boxes or protective casings (i.e., well covers), and therefore did not include them in the SiteWise input.

The GSR Team is assuming the use of hollow stem auger for the drilling of all boreholes for footprinting (it is assumed that footprint would not be much different for drive and wash).

The GSR Team is assuming the use of an NxQ rock bore barrel for the collection and evaluation of the underlying bedrock. This activity is included as part of the drilling for footprinting purposes.

Alternative 2– Pre-Design Investigation Activities

The GSR Team is assuming the use of a 4-hour pump test and packer testing/rising head aquifer testing to evaluate bedrock hydraulic conductivity. This activity was considered negligible for footprinting.

The GSR Team is assuming the use of a geophysical survey to evaluate bedrock contour and depth along the path of the proposal barrier wall. This activity was considered negligible for footprinting.

Alternative 2– Pre-Design Investigation Activities

<u>Input into "Remedial Investigation" tab of SiteWise Input Sheet.xls</u>

- Baseline Information
  - Remedial Investigation Cost
    - Total remedial investigation cost ($) – leave blank in SiteWise

- Material Production
  - Well Materials
    - Well Type 1-Represents the PVC for screen and casing of the overburden monitoring well and the two piezometers. Three wells, assumed an average of 36.6 feet deep, PVC (assumed Schedule 40) and 2 inch casing diameter.
    - Well Type 2-Represents the steel outer casing for the bedrock monitoring well. One well, assumed an average of 65 feet deep, Steel (assumed Schedule 40) and assumed 4 inch casing diameter (the steel represents the outer casing through the overburden).
  - Treatment Chemicals & Materials
  - Treatment Media
  - Construction Materials
  - Well Decommissioning
  - Bulk Material Quantities
    - Material 1- Sand filter pack for overburden well and 2 piezometers. Select "sand" and "cubic feet". To calculate volume of sand, determine total volume within borehole ($V=\pi*(2/12)^2*$interval) and subtract volume within well casing ($V=\pi*(1/12)^2*$interval) for the interval where sand will be present. For the three wells, total interval height is 12.5 + 7.5+7.5 = 27.5 feet total. Total volume of sand calculated is 1.80 cubic feet.
    - Material 2-Bentonite Seal for overburden well and 2 piezometers. Select "Bentonite" and "cubic feet". To calculate volume of bentonite, determine total volume within borehole ($V=\pi*(2/12)^2*$interval) and subtract volume within well casing ($V=\pi*(1/12)^2*$interval) for the interval where bentonite will be present. For the three wells, total interval height is 2+2+2 = 6 feet. Total volume of bentonite calculated is 0.39 cubic feet.
    - Material 3-Grout for overburden well and 2 piezometers. Select "Typical cement" to represent grout. Select "cubic feet". To calculate volume of grout, determine total volume within borehole ($V=\pi*(2/12)^2*$interval) and subtract volume within well casing ($V=\pi*(1/12)^2*$interval) for the interval where grout will be present. For the three wells, total interval height is 27.5 + 22.5+ 22.5 = 72.5 feet. Total volume of grout calculated is 4.74 cubic feet.
    - Material 4-Grout for bedrock well. Select "Typical cement" to represent grout. Select "cubic feet". To calculate volume of grout, determine total volume within borehole ($V=\pi*(3/12)^2*$interval) and subtract volume within well casing ($V=\pi*(2/12)^2*$interval) for the interval where grout will be present of 10 feet. Total volume of grout calculated is 1.96 cubic feet.
    - Material 5-Grout for four other borings. Select "Typical cement" to represent grout. Select "cubic feet". To calculate volume of grout, determine total volume within borehole ($V=\pi*(2/12)^2*155$ (total length of SHM-11-01, SHM-11-03, SHM-11-04, and SHM-11-05). Total volume of grout calculated is 13.53 cubic feet

Alternative 2– Pre-Design Investigation Activities

- Transportation
  - Personnel Transportation – Road
    - Trip 1- Light truck for drillers. Select gasoline. Two drillers travelling from a distance of 100 miles round trip, one trip per day for sixteen days.
    - Trip 2- Heavy duty truck to represent drill rig. Select "diesel", 100 miles round trip, one round trip to bring rig to and from site (assume rig left on-site for length of drilling). Select "1" passenger.
    - Trip 3-On-site consultant. Select "light truck" and "gasoline". Travelling distance is assumed by GSR team to be 40 miles round trip, one trip per day for sixteen days. One passenger.
  - Personnel Transportation – Air
  - Personnel Transportation – Rail
  - Equipment Transportation – Road
    - Trip 1-Transport of well casing materials. Select "diesel" and 50 miles one way. Estimated total weight (from SiteWise output sheet) equals 79 lbs (PVC) plus 701 lbs (steel) = 780 lbs = 0.39 tons.
    - Trip 2-Transport of sand, bentonite and grout. Select "diesel" and 50 miles one way. Total weight of all sand, bentonite and grout were obtained from SiteWise output file and equals 94.3 kg (sand) + 19.9 kg (bentonite) + 202.1 kg (cement) + 83.6 kg (cement) + 577.0 kg (cement) = 976.9 kg = 2,149 lbs = 1.07 tons.
    - Trip 3- Return trip of both empty material delivery trucks. Select "diesel" and 100 miles (2 trucks travelling 50 miles one way). Total weight is zero tons.
  - Equipment Transportation – Air
  - Equipment Transportation – Rail
  - Equipment Transportation – Water

- Equipment Use
  - Earthwork
  - Drilling
    - Event 1- Drilling for eight boreholes. Select "Hollow Stem Auger" for drilling method. GSR team assumes an average of two days for each borehole, for 16 hours per location. Choose "diesel" for fuel type.
  - Trenching
  - Pump Operation
  - Diesel and Gasoline Pumps
  - Blower, Compressor, Mixer, and Other Equipment
  - Generators
  - Agricultural Equipment
  - Capping Equipment
  - Mixing Equipment
  - Internal Combustion Engines
  - Other Fueled Equipment
  - Operator Labor
  - Laboratory Analysis
  - Other Known Onsite Activities

- Residual Handling
  - Residue Disposal/Recycling

  - Landfill Operations
  - Thermal/Catalytic Oxidizers

- Resource Consumption
  - Water Consumption
  - Onsite Land and Water Resource Consumption

Once SiteWise input is complete, go to "SiteWise_Input Sheet " for overall project and enter information (including Alternative File Name "Baseline"). Then go to "Generate Alternative" tab and click button labeled "Click to generate alternative using previously entered alternative name". Copies of the input and output summary sheets for this alternative are now located in the directory titled "RA_Baseline _NoFR_1". To store the "Remedial Action Investigation.xls" calculation sheet showing detailed calculations, open it in the overall SiteWise project directory when the appropriate input sheet is open, then do a "save as" to put it in the directory for this alternative using a name that indicates "will not update". Then open that file and do "data->edit links" and break the links. If the input sheet for this alternative ever changes, then this calculation sheet needs to be re-saved.

To edit input parameters for this alternative, you must go back to the ORIGINAL SiteWise input sheet and import this alternative using the "Do you want to reload a previously saved remedial alternative in the SiteWise input sheet?" field on the "Site Info" tab. After making necessary changes to the input sheet, re-export the alternative by going to the "Generate Alternative" tab and clicking the button labeled "Click to replace an existing alternative with the same name". Update saved calculation sheets as described above.

Alternative 2– Pre-Construction Investigation Sampling

Scope of Work

SHM-11-01 (Bore hole only)
- Split spoon (includes one geotechnical sample)
- Blow counts
- Rock cores

SHM-11-02 (Open hole Bedrock well with steel outer casing)
- Split spoons (includes one geotechnical sample)
- Blow counts
- Rock cores up to 15 ft into bedrock
- Rising head slug test/packer testing and 4-hour pump test
- Profiling samples at 10 ft intervals below the water table (submitted to lab and analyzed for As)
    - GW will be purged using a stainless steel bladder pump or a peristaltic-inertial pump
- Groundwater sampled for TAL metals and ammonia using low flow
- Water elevations collected

SHM-11-03
- Split spoon (includes one geotechnical sample)
- Blow counts
- Rock cores

SHM-11-04 and SHM-11-05
- No split spoons, and blow counts only if there is significant variability for the first three boreholes
- One geotechnical sample if significant variability in subsurface conditions detected in SHM-11-01 through SHM-11-03.
- Rock cores

SHM-11-06 (Overburden monitoring well)
- No split spoons, and blow counts only if there is significant variability for the first three boreholes
- One geotechnical sample if significant variability in subsurface conditions detected in SHM-11-01 through SHM-11-03.
- Rock cores
- Groundwater sampled for TAL metals and ammonia using low flow
- Profiling samples at 10 ft intervals below the water table (submitted to lab and analyzed for As)
    - GW will be purged using a stainless steel bladder pump or a peristaltic-inertial pump
- Water elevations collected

SHM-11-07 and SHM-11-08 (Piezometers)
- Soil samples and rock samples are not collected
- No blow counts collect
- Profiling samples at 10 ft intervals below the water table (submitted to lab and analyzed for As)
    - GW will be purged using a stainless steel bladder pump or a peristaltic-inertial pump
- Water elevations collected

Alternative 2– Pre-Construction Investigation Sampling

Transport of samples to laboratories:

- Assume ground courier to a groundwater lab, and separate courier to a geotechnical lab. Assume distance not to exceed 50 miles one way in each case. Assume that samples will account for approximately 50% of the courier's load.
- Assume all geotechnical samples in one shipment.
- Assume one groundwater sampling shipment for each well of 4 wells/piezometers to be profiled, plus 1 combined groundwater sampling shipment for the two wells to be sampled low-flow (i.e., 5 total shipments for groundwater sampling).

Alternative 2– Pre-Construction Investigation Sampling

Input into "Remedial Action Construction" tab of SiteWise Input Sheet.xls

- Baseline Information
  - Remedial Action Construction Cost
    - Total remedial action construction cost ($) – leave blank in SiteWise

- Material Production
  - Well Materials
  - Treatment Chemicals & Materials
  - Treatment Media
  - Construction Materials
  - Well Decommissioning
  - Bulk Material Quantities

- Transportation
  - Personnel Transportation – Road
    - Trip 1-Represents the on-site consultant that performs low-flow sampling. Select "light truck" and "gasoline". GSR team assumed a 40 mile round trip distance, with 1 trip taken, with 1 traveler.
  - Personnel Transportation – Air
  - Personnel Transportation – Rail
  - Equipment Transportation – Road
    - Trip 1- Represent courier transport of geotechnical samples and rock cores. Select "gasoline". GSR team estimated trip to be a one way distance of 50 miles. Weight of rock cores and geotechnical samples were estimated by GSR team to be approximately 0.5 tons (rough estimate).
    - Trip 2-Represent courier transport of groundwater samples. Select "gasoline". Distance was calculated by assuming five separate trips of 50 miles each with site samples accounting for 50% of total courier load (5*50*0.5=125 miles). Assumed cooler weights to be 20 lbs. each (=0.01 tons).
    - Trip 3-Represents empty trips to pick up samples from site. Total distance equals sum of mileage for trips 1 and 2, above (50+125=175 miles). Enter "0" for weight.
  - Equipment Transportation – Air
  - Equipment Transportation – Rail
  - Equipment Transportation – Water

- Equipment Use
  - Earthwork
  - Drilling
  - Trenching
  - Pump Operation
  - Diesel and Gasoline Pumps
  - Blower, Compressor, Mixer, and Other Equipment
  - Generators
  - Agricultural Equipment
  - Capping Equipment
  - Mixing Equipment

  - Internal Combustion Engines
  - Other Fueled Equipment
  - Operator Labor
  - Laboratory Analysis
  - Other Known Onsite Activities

- Residual Handling
  - Residue Disposal/Recycling
  - Landfill Operations
  - Thermal/Catalytic Oxidizers

- Resource Consumption
  - Water Consumption
  - Onsite Land and Water Resource Consumption

Once SiteWise input is complete, go to "SiteWise_Input Sheet " for overall project and enter information (including Alternative File Name "Baseline"). Then go to "Generate Alternative" tab and click button labeled "Click to generate alternative using previously entered alternative name". Copies of the input and output summary sheets for this alternative are now located in the directory titled "RA_Baseline _NoFR_1". To store the "Remedial Action Construction.xls" calculation sheet showing detailed calculations, open it in the overall SiteWise project directory when the appropriate input sheet is open, then do a "save as" to put it in the directory for this alternative using a name that indicates "will not update". Then open that file and do "data->edit links" and break the links. If the input sheet for this alternative ever changes, then this calculation sheet needs to be re-saved.

To edit input parameters for this alternative, you must go back to the ORIGINAL SiteWise input sheet and import this alternative using the "Do you want to reload a previously saved remedial alternative in the SiteWise input sheet?" field on the "Site Info" tab. After making necessary changes to the input sheet, re-export the alternative by going to the "Generate Alternative" tab and clicking the button labeled "Click to replace an existing alternative with the same name". Update saved calculation sheets as described above.

Alternative 2 – Grouted Sheet Pile Wall Construction

Scope of Work

- Barrier wall that is 800 to 950 feet long, 50 to 60 feet horizontal depth, 2.5 feet wide (*Draft Constructability Basis Report, p.5)*.
    - Materials
        - Estimation of materials extracted from website calculator that uses meters as input: http://www.arcelorprojects.nl/EN/calculation1.htm
        - 566 tons of sheet pile (estimated from using default "section" AZ 12-770 and entering approximate length of 300 m and height of 20 m)
        - Backfill likely to be minimal and is assumed by the GSR Team to be from onsite materials.
    - Transport of materials to site
        - Assume transport of any of the above materials would come from a distance no greater than 50 miles
    - Waste Disposal
        - The Draft Constructability Basis Report indicates that this type of barrier wall will not generate spoils.

- Transport of personnel to and from site
    - Specialty contractor for construction likely to come from Maryland, Pennsylvania or New Jersey (GSR Team assumes approximately 300 miles one-way from site). The GSR Team assumes 2 personnel from specialty contractor will be at the site for 7 weeks (Based on RSMeans estimated daily output of 690 vertical linear feet per day for sheet piling at 60 foot depth (estimated 3 feet wide, 33 feet width per day, 900 total width of wall divided by 33 feet per day is 27 days=5.5 working weeks with an estimated 8 days of site prep and site cleanup) with 4 trips home.
    - The GSR Team assumes specialty personnel stay at hotel within 5 miles of site.
    - The GSR Team assumes 8 additional personnel (site contractors and equipment operators) will be local from within 30 miles of the site on average.
- Landfill cap
    - Expansion of the existing landfill cap between the barrier and the landfill to minimize infiltration in that area (*Draft Constructability Basis Report* , p.5) appears minimal, estimated by the GSR Team to be ~3,750 square feet based on maps)
    - Materials
        - 300 ml polyvinylchloride (PVC) membrane cap (*Draft Constructability Basis Report* , p.2)
        - Soil and vegetation cover (assumed by GSR team to require imported clean fill for depth of 2 ft)
- Equipment use
    - Equipment (*Estimated from RSMeans, 2007)*
        - *1 crawler crane*
        - *1 Hammer, diesel, 22K ft-lb*
    - The GSR Team estimates that total fuel consumption is based on the use of the two pieces of equipment (listed in RSMeans, 2007) required for pile driving on site and the total time of remedy construction (Based on RSMeans estimated daily output of 690 vertical linear feet per day for sheet piling at 60 foot depth). The crawler crane was estimated to have a fuel efficiency of 8 L/hr and contribute 457 gallons of fuel use during the entire remedy construction (8L per hr/3.78 L in a gallon* 216 hours for remedy construction). The diesel hammer is estimated to have a fuel efficiency of 10 L

per hour and contribute 571 gallons of fuel use during remedy construction (10L per hr/3.78 L in a gallon * 216 hours for remedy construction).

- Transport of equipment to and from site
    - The crawler crane is assumed to come from no greater than 50 miles away, and weighs approximately 3 ton shipping weight (estimated from web search: http://www.mantiscranes.com/crane8012.php)
    - The diesel hammer is assumed to come from no greater than 50 miles from the site and weighs approximately 5 tons (estimated from web search: http://www.iceusa.com)

- Water consumption
    - Water consumption appears to be negligible for this remedy

Alternative 2 – Grouted Sheet Pile Wall Construction

Input into "Remedial Action Operations" tab of SiteWise Input Sheet.xls

- Baseline Information
  - Remedial Action Operations Cost and Duration
    - Total remedial action operations cost ($) – leave blank in SiteWise
    - Duration of remedial action operations (unit time) – 1 yr for this GSR evaluation because we have multiplied input items by number of years as part of the input

- Material Production
  - Well Materials
  - Treatment Chemicals & Materials
  - Treatment Media
  - Construction Materials
  - Well Decommissioning
  - Bulk Material Quantities
    - Material 1- Steel for the sheet piling (566 tons of sheet pile (estimated from using 390 sheets to construct a 900 foot long sheet pile wall that is 60 feet deep). Select "Steel", "pounds" and insert amount as 566 tons * 2000 pounds per ton=1,132,000 lbs.
    - Material 2- PVC liner for extension of landfill cap, in pounds, with 30 mil PVC=0.2 lbs per square foot (internet research), and estimated addition to cap (from maps) 3,750 square feet=0.2*3,750=750 pounds.
    - Material 3- Soil to cover PVC liner for extension of landfill cap. Select "cubic feet". Soil estimated to be 2 feet thick over 3,750 square feet extension=7,500 cubic feet.
- Transportation
  - Personnel Transportation – Road
    - Trip 1-Specialty contractor traveling from out of state. Assume cars, gasoline, 600 miles round trip (average distance from places that contractors are expected to come from), assume 4 round trips over the 7 weeks to site for 1 vehicle, 2 passengers per vehicle.
    - Trip 2-Specialty contractors traveling from hotel and out for lunch. Assume cars, gasoline, 10 miles round trip (average distance from nearby hotels), assume two round trips to site per day for 5 days per week for 7 weeks, for 1 vehicle, 2 passengers per vehicle.
    - Trip 3-Local Project team consultant and operators traveling from home to site for work. Assume a light truck, gasoline, 60 mile round trip, 8 trips per day for 5 days per week for 7 weeks, 1 traveler per vehicle.
  - Personnel Transportation – Air
  - Personnel Transportation – Rail
  - Equipment Transportation – Road
    - Trip 1-Transport of all equipment (and associated fuel) listed in Scope of Work to and from site. Select diesel, distance traveled is assumed to be 100 miles round trip for one vehicle, carrying 8 tons of equipment (estimated weight of equipment is 3 tons for crawler (estimated from web search: http://www.mantiscranes.com/crane8012.php)and 5 tons for hammer (estimated from web search: http://www.mantiscranes.com/crane8012.php)).

    - Trip 2-Return trip for empty vehicles in Trip 1, Select diesel, 1 vehicle traveling 100 miles round trip carrying 0 tons of weight.
    - Trip 3- Transport of PVC liner and soil for cap, equal to total of 432.6 tons, (obtained from SiteWise output file). Select diesel, and input the total distance as 220 miles (assuming each vehicle will hold 40 tons, this will require approximately 11 vehicles and assume each trip is 20 miles one way).
    - Trip 4-Return trip for vehicles that transported above materials in Trip 3. The total distance is 220 miles from 11 vehicles going 20 miles, one way. Each vehicle will hold 0 tons.
    - Trip 5-Represents delivery of 566 tons of steel sheet piling. Select "diesel", mileage=50 miles one way*14 vehicles=700 miles needed to transport all sheet piling with 40 tons per trip per vehicle.
    - Trip 6- Represents return trip of above vehicles without sheet piling (zero weight).

  - Equipment Transportation – Air
  - Equipment Transportation – Rail
  - Equipment Transportation – Water

- Equipment Use
  - Earthwork
  - Drilling
  - Trenching
  - Pump Operation
  - Diesel and Gasoline Pumps
  - Blower, Compressor, Mixer, and Other Equipment
  - Generators
  - Agricultural Equipment
  - Capping Equipment
  - Mixing Equipment
  - Internal Combustion Engines
    - Engine 1-Represents the fuel usage for the crawler, having a fuel efficiency of 8L/hour = 2.116 gal/hr (based on 3.78 L per gallon), over a period of 8 hours per day for 27 days=216 hours.
    - Engine 2- Represents the fuel usage for the hammer, having a fuel efficiency of 10L/hour = 2.646 gal/hr (based on 3.78 L per gallon), so total fuel usage for the remedy=10L per hour/3.78 L per gallon, for a period of 8 hours per day for 27 days=216 hours.
  - Other Fueled Equipment
  - Operator Labor
  - Laboratory Analysis
  - Other Known Onsite Activities

- Residual Handling
  - Residue Disposal/Recycling
  - Landfill Operations
  - Thermal/Catalytic Oxidizers

Alternative 2 – Grouted Sheet Pile Wall Construction

- Resource Consumption
  - Water Consumption
  - Onsite Land and Water Resource Consumption

Once SiteWise input is complete, go to "SiteWise_Input Sheet " for overall project and enter information (including Alternative File Name "Baseline"). Then go to "Generate Alternative" tab and click button labeled "Click to generate alternative using previously entered alternative name". Copies of the input and output summary sheets for this alternative are now located in the directory titled "RA_Baseline _NoFR_1". To store the "Remedial Action Operations.xls" calculation sheet showing detailed calculations, open it in the overall SiteWise project directory when the appropriate input sheet is open, then do a "save as" to put it in the directory for this alternative using a name that indicates "will not update". Then open that file and do "data->edit links" and break the links. If the input sheet for this alternative ever changes, then this calculation sheet needs to be re-saved.

To edit input parameters for this alternative, you must go back to the ORIGINAL SiteWise input sheet and import this alternative using the "Do you want to reload a previously saved remedial alternative in the SiteWise input sheet?" field on the "Site Info" tab. After making necessary changes to the input sheet, re-export the alternative by going to the "Generate Alternative" tab and clicking the button labeled "Click to replace an existing alternative with the same name". Update saved calculation sheets as described above.

Other Supporting Calculations:
Grouted Sheet Pile Wall (Alternative 2)

% of Total Energy Usage from Renewable Resources

- None identified (since remedy construction will not require electricity use)

Hazardous Air Pollutants

- None identified

.

Refined Materials Use

Material	Lbs	Basis
PVC (well casing)	79	Calculated by SiteWise output file
Steel (well casing)	701	Calculated by SiteWise output file
Cement (grout for overburden well and 2 piezometers)	444.7	Calculated by SiteWise output file
Cement (grout for bedrock well)	183.9	Calculated by SiteWise output file
Cement (grout for other borings)	1,269.2	Calculated by SiteWise output file
Steel (sheet piling)	1,132,000	Calculated by GSR Team
PVC (liner for cap extension)	750	Calculated by GSR Team
Total	***1,135,427.8 lbs***	

Unrefined Materials Use

Material	Tons	Basis
Bentonite (seal on wells)	0.1	Calculated by SiteWise output file
Sand (filter packs)	0.1	Calculated by SiteWise output file
Soil (cover for cap extension)	432.2	Calculated by SiteWise output file
Total	***432.4 tons***	

Tons of Non-Hazardous Waste

- None identified (will be placed under existing cap with equipment already mobilized to the site)

Tons of Hazardous Waste

- None identified

Alternative 2– Other Supporting Calculations

% of Potential Waste Recycled

- N/A

Risks to On-Site Workers and from Transportation

- Based on SiteWise output
    - On-Site worker injuries or fatalities = 0.003
    - Transportation related injuries or fatalities = 0.02

Heavy Truck Trips through Residential Areas

None identified

Project: GSR Pilot for Shepley's Hill Landfill (Red Cove)
Option or Alternative: Alternative 2: Grouted Sheet Pile Wall
Current Date: 4/10/2012

year	up-front cost	annual cost	present value of cost each year	cumulative cash flow	
		(no discounting)	2.7%	no discounting	2.7%
0	$3,630,876	$0	$3,630,876	$3,630,876	$3,630,876
1	$0	$5,000	$4,869	$3,635,876	$3,635,745
2	$0	$5,000	$4,741	$3,640,876	$3,640,485
3	$0	$5,000	$4,616	$3,645,876	$3,645,101
4	$0	$5,000	$4,495	$3,650,876	$3,649,596
5	$0	$5,000	$4,376	$3,655,876	$3,653,972
6	$0	$5,000	$4,261	$3,660,876	$3,658,233
7	$0	$5,000	$4,149	$3,665,876	$3,662,383
8	$0	$5,000	$4,040	$3,670,876	$3,666,423
9	$0	$5,000	$3,934	$3,675,876	$3,670,357
10	$0	$5,000	$3,831	$3,680,876	$3,674,188
11	$0	$5,000	$3,730	$3,685,876	$3,677,917
12	$0	$5,000	$3,632	$3,690,876	$3,681,549
13	$0	$5,000	$3,536	$3,695,876	$3,685,086
14	$0	$5,000	$3,443	$3,700,876	$3,688,529
15	$0	$5,000	$3,353	$3,705,876	$3,691,882
16	$0	$5,000	$3,265	$3,710,876	$3,695,146
17	$0	$5,000	$3,179	$3,715,876	$3,698,325
18	$0	$5,000	$3,095	$3,720,876	$3,701,421
19	$0	$5,000	$3,014	$3,725,876	$3,704,435
20	$0	$5,000	$2,935	$3,730,876	$3,707,369
21	$0	$5,000	$2,858	$3,735,876	$3,710,227
22	$0	$5,000	$2,782	$3,740,876	$3,713,009
23	$0	$5,000	$2,709	$3,745,876	$3,715,718
24	$0	$5,000	$2,638	$3,750,876	$3,718,356
25	$0	$5,000	$2,569	$3,755,876	$3,720,925
26	$0	$5,000	$2,501	$3,760,876	$3,723,426
27	$0	$5,000	$2,435	$3,765,876	$3,725,862
28	$0	$5,000	$2,371	$3,770,876	$3,728,233
29	$0	$5,000	$2,309	$3,775,876	$3,730,542
30	$0	$5,000	$2,248	$3,780,876	$3,732,790
31	$0	$5,000	$2,189	$3,785,876	$3,734,980
32	$0	$5,000	$2,132	$3,790,876	$3,737,111
33	$0	$5,000	$2,076	$3,795,876	$3,739,187
34	$0	$5,000	$2,021	$3,800,876	$3,741,208
35	$0	$5,000	$1,968	$3,805,876	$3,743,176
36	$0	$5,000	$1,916	$3,810,876	$3,745,092
37	$0	$5,000	$1,866	$3,815,876	$3,746,958
38	$0	$5,000	$1,817	$3,820,876	$3,748,774
39	$0	$5,000	$1,769	$3,825,876	$3,750,543
40	$0	$5,000	$1,722	$3,830,876	$3,752,266

Project: GSR Pilot for Shepley's Hill Landfill (Red Cove)
Option or Alternative: Alternative 2: Grouted Sheet Pile Wall
Current Date: 4/10/2012

year	up-front cost	annual cost	present value of cost each year	cumulative cash flow	
		(no discounting)	2.7%	no discounting	2.7%
41	$0	$5,000	$1,677	$3,835,876	$3,753,943
42	$0	$5,000	$1,633	$3,840,876	$3,755,576
43	$0	$5,000	$1,590	$3,845,876	$3,757,166
44	$0	$5,000	$1,548	$3,850,876	$3,758,715
45	$0	$5,000	$1,508	$3,855,876	$3,760,222
46	$0	$5,000	$1,468	$3,860,876	$3,761,690
47	$0	$5,000	$1,429	$3,865,876	$3,763,120
48	$0	$5,000	$1,392	$3,870,876	$3,764,512
49	$0	$5,000	$1,355	$3,875,876	$3,765,867
50	$0	$5,000	$1,320	$3,880,876	$3,767,186
51	$0	$5,000	$1,285	$3,885,876	$3,768,471
52	$0	$5,000	$1,251	$3,890,876	$3,769,723
53	$0	$5,000	$1,218	$3,895,876	$3,770,941
54	$0	$5,000	$1,186	$3,900,876	$3,772,127
55	$0	$5,000	$1,155	$3,905,876	$3,773,282
56	$0	$5,000	$1,125	$3,910,876	$3,774,407
57	$0	$5,000	$1,095	$3,915,876	$3,775,502
58	$0	$5,000	$1,066	$3,920,876	$3,776,568
59	$0	$5,000	$1,038	$3,925,876	$3,777,606
60	$0	$5,000	$1,011	$3,930,876	$3,778,617
61	$0	$5,000	$984	$3,935,876	$3,779,602
62	$0	$5,000	$959	$3,940,876	$3,780,560
63	$0	$5,000	$933	$3,945,876	$3,781,494
64	$0	$5,000	$909	$3,950,876	$3,782,402
65	$0	$5,000	$885	$3,955,876	$3,783,287
66	$0	$5,000	$862	$3,960,876	$3,784,149
67	$0	$5,000	$839	$3,965,876	$3,784,988
68	$0	$5,000	$817	$3,970,876	$3,785,805
69	$0	$5,000	$795	$3,975,876	$3,786,600
70	$0	$5,000	$775	$3,980,876	$3,787,375
71	$0	$5,000	$754	$3,985,876	$3,788,129
72	$0	$5,000	$734	$3,990,876	$3,788,863
73	$0	$5,000	$715	$3,995,876	$3,789,578
74	$0	$5,000	$696	$4,000,876	$3,790,275
75	$0	$5,000	$678	$4,005,876	$3,790,953
76	$0	$5,000	$660	$4,010,876	$3,791,613
77	$0	$5,000	$643	$4,015,876	$3,792,255
78	$0	$5,000	$626	$4,020,876	$3,792,881
79	$0	$5,000	$609	$4,025,876	$3,793,491
80	$0	$5,000	$593	$4,030,876	$3,794,084
81	$0	$5,000	$578	$4,035,876	$3,794,662

Project: GSR Pilot for Shepley's Hill Landfill (Red Cove)
Option or Alternative: Alternative 2: Grouted Sheet Pile Wall
Current Date: 4/10/2012

year	up-front cost	annual cost		present value of cost each year		cumulative cash flow	
		(no discounting)		2.7%		no discounting	2.7%
82	$0	$5,000		$563		$4,040,876	$3,795,224
83	$0	$5,000		$548		$4,045,876	$3,795,772
84	$0	$5,000		$533		$4,050,876	$3,796,306
85	$0	$5,000		$519		$4,055,876	$3,796,825
86	$0	$5,000		$506		$4,060,876	$3,797,331
87	$0	$5,000		$492		$4,065,876	$3,797,823
88	$0	$5,000		$479		$4,070,876	$3,798,303
89	$0	$5,000		$467		$4,075,876	$3,798,770
90	$0	$5,000		$455		$4,080,876	$3,799,224
91	$0	$5,000		$443		$4,085,876	$3,799,667
92	$0	$5,000		$431		$4,090,876	$3,800,098
93	$0	$5,000		$420		$4,095,876	$3,800,517
94	$0	$5,000		$409		$4,100,876	$3,800,926
95	$0	$5,000		$398		$4,105,876	$3,801,324
96	$0	$5,000		$387		$4,110,876	$3,801,711
97	$0	$5,000		$377		$4,115,876	$3,802,089
98	$0	$5,000		$367		$4,120,876	$3,802,456
99	$0	$5,000		$358		$4,125,876	$3,802,814
100	$0	$5,000		$348		$4,130,876	$3,803,162

Net Present Value (NPV)-> $3,803,162

*positive dollar value is a "cost", negative dollar value is a "savings"

GSR Team Calculations to Split Energy Results from SiteWise into "Direct" and "Indirect"
Grouted Sheet Pile Wall (Alternative 2)

phase	Reported by SiteWise activity	energy used (MMBTU)	Assigned by GSR Team from SiteWise Output: Scope 1 (direct) energy used (MMBTU)	Scope 2 (indirect) energy used (MMBTU)	Scope 3 (indirect) energy used (MMBTU)	Total Calculated by GSR Team
Pre-Construction Investigation Activities – "Remedial Investigation" tab	Consumables	16.51	0.00	0.00	16.51	16.51
	Transportation-Personnel	17.41	0.00	0.00	17.41	17.41
	Transportation-Equipment	3.69	0.00	0.00	3.69	3.69
	Equipment Use and Misc	131.28	106.34	0.00	24.94	131.28
	Residual Handling	0.00	0.00	0.00	0.00	0.00
	Sub-Total	168.88	106.34	0.00	62.55	168.88
Pre-Construction Investigation Sampling – Uses "Remedial Action Construction" tab	Consumables	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	0.28	0.00	0.00	0.28	0.28
	Transportation-Equipment	6.58	0.00	0.00	6.58	6.58
	Equipment Use and Misc	0.00	0.00	0.00	0.00	0.00
	Residual Handling	0.00	0.00	0.00	0.00	0.00
	Sub-Total	6.86	0.00	0.00	6.86	6.86
Slurry Wall Construction – Uses "Remedial Action Operations" tab	Consumables	16950.34	0.00	0.00	16950.34	16950.34
	Transportation-Personnel	131.63	0.00	0.00	131.63	131.63
	Transportation-Equipment	58.62	0.00	0.00	58.62	58.62
	Equipment Use and Misc	139.73	113.18	0.00	26.55	139.73
	Residual Handling	0.00	0.00	0.00	0.00	0.00
	Sub-Total	17280.32	113.18	0.00	17167.14	17280.32
total		17456.06	219.52	0.00	17236.54	17456.06

Note: *Electricity use reported by SiteWise Version 2.0 in units of kWh is "Direct Scope 1", meaning it is energy consumed at the location of the project. However, energy use associated with electricity reported by SiteWise in units of MMBtu is a life-cycle value which also includes a factor to account for energy used elsewhere required to generate the electricity ("Indirect Scope 2"). Here, 33% of the life-cycle value reported by SiteWise is considered to be "Scope 1" on-site energy use, and 67% is considered to be "Scope 2" energy used in electricity generation.*

SiteWise Version 2.0 uses fuel energy values from U.S. Department of Energy, Argonne National Laboratory, Transportation Technology R&D Center, GREET 1.8d.1, Fuel-Cycle model, 2010. This version of the GREET model reports that for Gasoline and Diesel, approximately 19% of GHG emissions are upstream emissions (scope 3) and 81% are tailpipe emissions (scope 1). For this analysis, it is assumed that energy is used in these same proportions, and therefore the energy use reported by SiteWise is split between scope 3 and scope 1 in these ratios.

GSR Team Calculations to Split GHG Results from SiteWise into "Direct" and "Indirect"
Grouted Sheet Pile Wall (Alternative 2)

phase	Reported by SiteWise		Assigned by GSR Team from SiteWise Output			Total Calculated by GSR Team
			Scope 1 (direct)	Scope 2 (indirect)	Scope 3 (indirect)	
	activity	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	
Pre-Construction Investigation Activities – “Remedial Investigation” tab	Consumables	1.70	0.00	0.00	1.70	1.70
	Transportation-Personnel	1.37	0.00	0.00	1.37	1.37
	Transportation-Equipment	0.28	0.00	0.00	0.28	0.28
	Equipment Use and Misc	10.87	8.81	0.00	2.07	10.87
	Residual Handling	0.00	0.00	0.00	0.00	0.00
	Sub-Total	14.23	8.81	0.00	5.42	14.23
Pre-Construction Investigation Sampling – Uses “Remedial Action Construction” tab	Consumables	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	0.02	0.00	0.00	0.02	0.02
	Transportation-Equipment	0.48	0.00	0.00	0.48	0.48
	Equipment Use and Misc	0.00	0.00	0.00	0.00	0.00
	Residual Handling	0.00	0.00	0.00	0.00	0.00
	Sub-Total	0.50	0.00	0.00	0.50	0.50
Slurry Wall Construction – Uses “Remedial Action Operations” tab	Consumables	1406.04	0.00	0.00	1406.04	1406.04
	Transportation-Personnel	10.44	0.00	0.00	10.44	10.44
	Transportation-Equipment	4.49	0.00	0.00	4.49	4.49
	Equipment Use and Misc	12.78	10.35	0.00	2.43	12.78
	Residual Handling	0.00	0.00	0.00	0.00	0.00
	Sub-Total	1433.74	10.35	0.00	1423.39	1433.74
Total		1448.48	19.16	0.00	1429.31	1448.48

Note: CO2e reported by SiteWise Version 2.0 for electricity use is all associated with generation of the electricity (“Indirect Scope 2”).

SiteWise Version 2.0 use fuel emission factors from U.S. Department of Energy, Argonne National Laboratory, Transportation Technology R&D Center, GREET 1.8d.1, Fuel-Cycle model, 2010. This version of the GREET model reports that for gasoline and diesel, approximately 19% of GHG emissions are upstream emissions (Scope 3) and 81% are tailpipe emissions (Scope 1). For this analysis, the GHG emissions reported by SiteWise are split between Scope 3 and Scope 1 in these ratios.

FINAL REPORT

PILOT PROJECT
GREEN AND SUSTAINABLE REMEDIATION EVALUATION:
UMATILLA CHEMICAL DEPOT (OU3)
UMATILLA, OREGON

Prepared for:

U.S. Army Corps of Engineers
Environmental and Munitions Center of Expertise
1616 Capitol Ave, Suite 9200
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Contract No. W912DQ-08-D-0019
Delivery Order No. ZW02

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February 7, 2012

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PREFACE

The US Army Engineering and Support Center, Huntsville (USAESCH), Environmental and Munitions Center of Expertise (EM CX) has contracted Tetra Tech EC, Inc. (Tetra Tech) under Contract W912DQ-08-D-0019, Delivery Order No. ZW02, to conduct and document a Study that follows the process of considering, incorporating, documenting, and evaluating the benefits of green and sustainable remediation (GSR) practices. The objective of this Task Order is to: (1) Follow the consideration and incorporation of GSR practices into Army environmental remediation projects; (2) Ascertain the effectiveness of the GSR practices that are considered and incorporated; and (3) Provide procedures by which GSR practices that are shown to be effective can be identified, considered, implemented and documented by Project Teams working on Army sites. The information obtained from this Study will be used to provide recommendations to the Office of the Assistant Chief of Staff for Installation Management (OACSIM) for development of Army-wide GSR guidance and policy. This document has been prepared in accordance with the Task Order Statement of Work (SOW) entitled "*Evaluation of Consideration and Incorporation of Green and Sustainable Remediation (GSR) Practices in Army Environmental Remediation*" (26 July 2010).

The Project Delivery Team (PDT) consists of representatives and subject matter experts (SMEs) from the following organizations:

- EM CX;
- OACSIM;
- National Guard Bureau (NGB);
- Army Environmental Command (AEC);
- Tetra Tech;
- Office of the Deputy Assistant Secretary of the Army-Environment, Safety, and Occupational Health (ODASA (ESOH));
- Headquarters US Army Corps of Engineers (HQ USACE) Formerly Used Defense Sites (FUDS) program;
- HQ USACE Environmental Community of Practice (ECoP) Military Munitions Support Services (M2S2);
- Huntsville Center Environmental Program; and
- Army Environmental Policy Institute (AEPI)

Specific representatives of those organizations are listed on the table at the end of this preface. This report pertains to one of the pilot projects conducted as part of the Study. Tetra Tech personnel who provided the most significant contributions to this report are as follows:

- Preparation
    - Rob Greenwald (Project Manager)
    - Sarah Farron

- Review
    - Doug Sutton (IRP GSR Technical Lead)

Sincere thanks are extended to the Project Team associated with this pilot project, for their willingness to participate in this Study and for their efforts that were associated with their participation.

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Professional in Charge:

Douglas J. Sutton

Doug Sutton, PhD, PE, LEED

2/7/12
Date

ACRONYMS AND ABBREVIATIONS

ACSIM	Assistant Chief of Staff for Installation Management
AEC	Army Environmental Command
AEPI	Army Environmental Policy Institute
BMPs	Best Management Practices
CO2	Carbon dioxide
CO2e	Equivalent Global Warming Potential of Carbon Dioxide
CSM	Conceptual Site Model
DoD	Department of Defense
ECoP	Environmental Community of Practice
EM CX	Environmental and Munitions Center of Expertise
ESOH	Environment, Safety, and Occupational Health
EWs	Extraction Wells
FFS	Focused Feasibility Study
FUDS	Formerly Used Defense Sites
GAC	Granular Activated Carbon
GHG	Greenhouse gas
gpm	Gallons per minute
GSR	Green and Sustainable Remediation
HP	Horsepower
HQ USACE	Headquarters US Army Corps of Engineers
HRS	Hours
IDW	Investigation Derived Waste
IRP	Installation Restoration Program
Kg	Kilograms
lbs	Pounds
LTM	Long Term Monitoring
M2S2	Military Munitions Support Services
MMBtu	Million Metric British Thermal Units
MMRP	Military Munitions Response Program
NGB	National Guard Bureau
NOx	Nitrogen Oxides
NPV	Net present value
NWPP	Northwest Power Pool Area sub-region of the Western Electric Coordinating Council
O&M	Operations and Maintenance
OACSIM	Office of the Assistant Chief of Staff for Installation Management
ODASA	Office of the Deputy Assistant Secretary of the Army
OUs	Operable Units
P&T	Pump and Treat
PDT	Project Delivery Team
PM	Particulate Matter
POTW	Publicly Operated Treatment Works
RACER	Remedial Action Cost Engineering Requirements
RDX	Hexahydro-l,3,5-trinitro-l,3,5-triazine
RECs	Renewable Energy Certificates
RSE	Remediation System Evaluation
SiteWise	Battelle SiteWise™ Sustainable Environmental Remediation Tool
SMEs	Subject matter experts
SOW	Statement of Work

SOx	Sulfur Oxides
TNT	2,4,6-trinitrotoluene
UMCD	Umatilla Chemical Depot
US	United States
USACE	United States Army Corps of Engineers
USAESCH	US Army Engineering and Support Center, Huntsville
VFD	Variable Frequency Drive

1.0 INTRODUCTION

1.1 ACSIM GSR STUDY AND PURPOSE OF THIS GSR EVALUATION

The US Army Engineering and Support Center, Huntsville (USAESCH), Environmental and Munitions Center of Expertise (EM CX) has contracted Tetra Tech EC, Inc. (Tetra Tech) under Contract W912DQ-08-D-0019, Delivery Order No. ZW02, to conduct and document a Study that follows the process of considering, incorporating, documenting, and evaluating the benefits of green and sustainable remediation (GSR) practices (hereafter referred to as "the Study"). Pursuant to the Department of Defense (DoD) Memorandum "*Consideration of Green and Sustainable Remediation Practices in the Defense Environmental Restoration Program*" (DoD, 2009), GSR employs strategies throughout the remedial process that:

- Use natural resources and energy efficiently;
- Reduce negative impacts on the environment;
- Minimize or eliminate pollution at its source;
- Protect and benefit the community at large; and
- Reduce waste to the greatest extent possible.

The objective of the Study is to: (1) Follow the consideration and incorporation of GSR practices into Army environmental remediation projects; (2) Ascertain the effectiveness of the GSR practices that are considered and incorporated; and (3) Provide procedures by which GSR practices that are shown to be effective can be identified, considered, implemented and documented by project teams working on Army sites. The information obtained from this Study will be used to provide recommendations to the Office of the Assistant Chief of Staff for Installation Management (OACSIM) for development of Army-wide GSR guidance and policy.

One component of the Study is to perform a GSR evaluation at 12 Army "Pilot Projects" that are in various phases of the remedial process. This report presents the Pilot Project GSR Evaluation for the Umatilla Chemical Depot OU3 (hereafter referred to as "Umatilla"). This GSR evaluation has been conducted using an approach developed during the Study and documented in the following report: *Process for Consideration and Incorporation of Green and Sustainable Remediation (GSR) Practices in Army Environmental Remediation (final report dated 26 May 2011).* One purpose for the pilot projects is to provide testing of the GSR approach developed during the Study. That approach will be refined and finalized later in the Study based on lessons learned from this and other pilot projects. In addition, it is anticipated that this GSR evaluation may provide the Project Team for Umatilla with information and/or recommendations that will be beneficial for their project.

This report refers to "teams" that are defined as follows:

- Study Team: This is the team conducting the Study being led by USACE EM CX that follows the process of considering, incorporating, documenting, and evaluating the benefits of green and sustainable remediation practices for Army projects.

- Project Team: Refers to those associated with implementation of the remedial process for the pilot projects.

- GSR Team: Refers to the personnel that perform a specific GSR evaluation. For this Study, the GSR Team consists of personnel from Tetra Tech, which is a contractor to USACE for the Study.

In this Study, an "EM CX liaison" for each of the pilot projects serves as a bridge between the USACE Study project manager (Carol Dona), the Study contractor performing the GSR evaluation (Tetra Tech), and the Project Team manager for the specific pilot. For this pilot project the EM CX Liaison is Carol Dona.

1.2 TECHNICAL OVERVIEW

1.2.1 Overview of Site Location, Setting, and Contamination

This GSR evaluation pertains to the Explosives Washout Lagoons Groundwater (Operable Unit 3) at the Umatilla Chemical Depot (UMCD) near Hermiston, Oregon. The location of UMCD is illustrated on Figure 1-1. The Explosives Washout Lagoons were two unlined rectangular lagoons where wash water from a munitions processing plant was discharged from the 1950s until 1965. The location of the washout lagoons was just northwest of extraction well EW-3 (in the vicinity of the shaded "lagoon injection" on Figure 1-4). The historical discharges to the washout lagoons caused contamination of groundwater. The primary contaminants in groundwater are hexahydro-l,3,5-trinitro-l,3,5-triazine (RDX) and 2,4,6-trinitrotoluene (TNT). The RDX Plume (see Figure 1-2) is significantly greater in extent than the TNT plume (see Figure 1-3) because the TNT has more potential for natural attenuation (sorption and degradation) under the site groundwater geochemistry than RDX. The cleanup levels are 2.1 ug/l for RDX and 2.8 ug/l for TNT.

1.2.2 Remedial Phase and Status

A pump and treat (P&T) system began operation in 1996 and operated until February 2009, at which point P&T operations were suspended so that pilot tests could be conducted (evaluate pulse pumping operation for potential to increase treatment efficiency and "push-pull" tests for in-situ bioremediation substrates) followed by evaluation of alternative remedy options. The previously operated P&T system consisted of:

- three extraction wells (EWs) as illustrated on Figure 1-4 (EW-1, EW-3, and EW-4)
- treatment of extracted water via granular activated carbon (GAC), consisting of two parallel treatment trains that each included two 20,000 pound (lb) carbon vessels
- recharge of treated water at infiltration galleries

There were four potential recharge locations (also illustrated on Figure 1-4). One of those was located in the vicinity of the washout lagoons, and recharge at that gallery only occurred in the initial period of P&T (until March 2000) to promote flushing of the source area. The other three recharge locations are located to the northwest, southwest, and southeast of the source areas (see Figure 1-4). The infiltration gallery to the northwest was taken out of service in 2002 based on the results of a groundwater modeling optimization study.

Based on Table 3-1 of the Draft Final FFS, the following extraction and recharge rates would be representative of continued operation of the P&T system (i.e., generally represent the pumping rates at the time of system shut-down in 2009):

- EW-1: 118 gpm
- EW-3: 76 gpm
- EW-4: 950 gpm
- Recharge of 1,144 gpm total, split equally between IF-2 (the gallery to the southeast) and IF-3 (the gallery to the southwest)

This GSR evaluation was performed based on the Draft Final Focused Feasibility Study (FFS) which was performed to evaluate alternatives to continuing the previous P&T system because the P&T system has been observed to be less effective over time at removing contaminant mass and shrinking the plume extent. Furthermore, the previous P&T system does not effectively address a lobe of the contaminant plume to the southeast of the main plume area, in the vicinity of monitoring well 4-25 (see Figure 1-2).

The Draft Final FFS evaluated the following four basic remedial alternatives. Each alternative in the FFS was costed for 15 years, though it was not stated in the FFS that any of the alternatives would achieve cleanup standards throughout the plume in 15 years. The four alternatives in the FFS are as follows:

- *Alternative 1 - Continued Pump and Treat*. This alternative assumes continued groundwater pumping through the current treatment system, which includes three extraction wells (at the extraction rates provided above) and a treatment plant with two dual-bed GAC units. A pulse pumping variation of this alternative was eliminated during the FFS evaluation because pilot testing of the pulse pumping demonstrated it was less effective at removing mass and less effective at hydraulic containment. The net present value (NPV) of this alternative over 15 years was estimated in the Draft Final FFS at $4.8M.

- *Alternative 2 - Pump and Treat Expansion*. This alternative assumes groundwater pumping through an expanded P&T system, which includes current infrastructure and two additional extraction wells. The locations of the two new extraction wells are illustrated on Figure 1-4. Extraction well EXT-1 (400 gpm) would be added in a plume lobe (near monitoring well 4-25) that is not addressed by the existing extraction wells, and extraction well EXT-2 (100 gpm) would be located in the main plume area to the southeast of EW-1. Other extraction rates would be similar to Alternative 1, except EW-4 would be pumped at 750 gpm rather than 950 gpm. Similar to Alternative 1, a pulse pumping variation of this alternative was eliminated during the FFS evaluation because pilot testing of the pulse pumping demonstrated it was less effective at removing mass and less effective at hydraulic containment. The NPV of this alternative over 15 years was estimated in the Draft Final FFS at $6.2M.

- *Alternative 3 – Bioremediation*. This alternative assumes injection of carbon substrate into the subsurface through the existing lagoon infiltration gallery and a new network of injection and extraction wells. Groundwater would no longer be treated via GAC. Based on microcosm tests and push-pull test results (test details discussed in Draft Final FFS Appendix B), the Project Team concluded that corn syrup would be the most effective bioremediation substrate at full-scale. The Draft Final FFS assumes the corn syrup would be delivered by heated tanker rail car from Memphis, TN to Seattle, WA. The substrate would then be transported by tanker trucks to the site at UMCD, where it would be off loaded into storage tanks. The storage tanks (which would require heating) would house the substrate before mixing it with groundwater and injecting it into the subsurface. This alternative, as described in the Draft Final FFS, would require installation of 10 full-time injection wells, 1 full-time extraction well, and 9 wells that would alternate between extraction and injection. This alternative would actively target RDX concentrations greater than 20 ug/l (the Project Team indicated that active treatment to the RDX cleanup criterion of 2.1 ug/l would not be practicable, and assumes that active treatment of the RDX plume greater than 20 ug/l will ultimately allow passive remediation to achieve the cleanup goals over time for most of the aquifer). The substrate injection/groundwater circulation schedule included three cycles of 120 days per year for the first five years (each cycle included a period of substrate injection/groundwater circulation followed by a resting period). Injection frequency in years 6 to 15 would likely be decreased based on performance of the remedy during the first five years. The NPV of this alternative over 15 years was estimated in the Draft Final FFS at $30.7M.

- *Alternative 4 - Pump and Treat Expansion and Bioremediation.* This alternative includes the following:

    - For the first 5 years[1], there would be an expanded P&T system with two new extraction well locations as per Alternative 2. EXT-1 would pump at 400 gpm and EW-4 would pump at 750 gpm continuously for five years. The other extraction wells would cycle between on and off for the first five years in conjunction with in-situ bioremediation in the former waste lagoon area (infiltration of extracted water from EW-1 and EW-3, amended with corn syrup, into the lagoon infiltration gallery). The amended water would be placed into the lagoon for 7 days, followed by 83 days of rest for all the extraction wells except for more distant wells EW-4 and EXT-1. Lagoon area treatment is included under Alternative 3 as well.

    - For the next 10 years, the P&T system would be eliminated (i.e., no treatment via GAC), and infiltration of amended water to the waste lagoon would also be eliminated. In place of those items, an in-situ bioremediation program would be established based on carbon substrate injection (corn syrup) into the subsurface through a new network of injection wells. Appendix C of the Draft Final FFS assumes that for the first 2 years of this period there would be installation of 4 new injection wells (plus use of a previous injection well from a pilot study and conversion of one extraction well to an injection well). These four new injection well locations are illustrated on Figure 1-4. The Draft Final FFS then assumes an additional four injection wells will be added for the subsequent 8 year period, based on results from the system operation (these locations are not included on Figure 1-4).

    - Similar to Alternative 3, the Draft Final FFS assumes the corn syrup would be delivered by heated tanker rail car from Memphis, TN to Seattle, WA. The substrate would then be transported by tanker trucks to the site at UMCD, where it would be off loaded into storage tanks. The storage tanks (which would require heating) would house the substrate before mixing it with groundwater and injecting it into the subsurface.

    - The NPV of this alternative over 15 years was estimated in the Draft Final FFS at $14.3M.

In the Draft Final FFS, Alternative 4 (Pump and Treat Expansion and Bioremediation) was selected as the recommended remedy. The FFS assumes that P&T only (Alternatives 1 and 2) would likely not achieve cleanup standards in 15 years and would likely leave more mass in place in the 15 year period than

[1] Timeframes and durations of activities for Alternative 4 were fixed for costing purposes in the FFS but would be subject to change/optimization based on measured site data during implementation. This GSR evaluation was performed using activity durations/timeframes established in the FFS.

Alternative 4. This GSR evaluation focuses on Alternative 4. It is expected that the results of this GSR evaluation can be considered and/or referenced within the Final FFS.

1.3 DOCUMENTS REVIEWED AND CALLS/MEETINGS CONDUCTED

The following project documents were reviewed for this evaluation:

- Draft Final Focused Feasibility Study (FFS) for Groundwater at the Explosives Washout Lagoon (EWL) Area, Operable Unit 3 (OU3), at the Umatilla Chemical Depot, Umatilla, OR (Draft Final, USACE, 26 August 2011)
- RACER cost-estimation database file associated with the Draft Final FFS
- Pulse Pumping Optimization Evaluation, August, 2009 Pulse Pumping Event (SCS Engineers and EMR Corporation, October 2009) and Pulse Pumping Technical Memorandum (EMR, 5 October 2009)
- Groundwater Treatment Plant Systems Operations and Maintenance Manual (SCS Engineers, January 2008)
- Independent Technical Review: Exit Strategy Development, Washout Lagoons Pump And Treat Site, Umatilla Chemical Depot, Hermiston, OR (Final Draft, USACE HTWR CX, December 2006)

In addition, the GSR Team was provided additional information by the Project Team via email in response to questions regarding assumptions used in RACER and/or values to assume for the quantitative footprinting presented later in this GSR evaluation.

The GSR approach being implemented in the Study typically includes an introductory conference call (referred to as the "Step 3" call) to introduce the Project Team to the Study, to arrange for transfer of information to the GSR Team, and to schedule a more detailed "Step 5" call. For this pilot project, the EM CX liaison informally addressed those items with the Project Team, so a "Step 3" call did not occur.

A more detailed conference call, referred to as the "Step 5" conference call, was conducted on 13 September 2011 and lasted approximately two hours. During this call the GSR Team used the list of GSR Best Management Practices (BMPs) developed for the Study as an outline to ask questions to the Project Team and allow the Project Team to provide pertinent information to the GSR Team. Participants for the "Step 5" call are listed in Table 1-1.

Table 1-1
Step 5 Call Participants, 13 September 2011

Participants			
Name	**Organization**	**Phone**	**Email**
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1.4 STRUCTURE OF THIS REPORT

This GSR evaluation report is structured as follows:

- Section 1: Introduction
- Section 2: Key GSR Findings
  - Review of BMPs
  - Quantitative Footprint Analysis for Alternative 4 (Baseline)
  - Quantitative Footprint Analysis for Potential Variations on the Baseline
    - Variation 1 – Initial P&T and In-Situ Bio at Waste Lagoon for 3 Years Instead of 5 Years
    - Variation 2 – Ship Lab Samples to a Closer Lab
  - Other Qualitative Considerations
- Section 3: GSR Recommendations

Supporting information and calculations for quantitative aspects of the evaluation are provided in appendices, and spreadsheet files for the SiteWise tool are attached electronically.

2.0 KEY GSR FINDINGS

2.1 REVIEW OF BEST MANAGEMENT PRACTICES (BMPs)

2.1.1 BMP Tables Completed by GSR Team

The GSR Team and the Project Team used a list of GSR BMPs as an outline to exchange information and ideas pertinent to application of GSR practices for this pilot project. The GSR Team subsequently completed the BMP tables included in Appendix A, based on the data provided by the Project Team in the form of documents as well as discussions during the Step 5 call. Table 2-1 summarizes information entered on the BMP tables in Appendix A, specifically with respect to the number of BMPs that appear to be applicable for this pilot project, the number of BMPs that appear to be practical for this pilot project, the number of BMPs that have been implemented prior to this GSR evaluation, and the number of BMPs that maybe associated with potential cost savings for this pilot project.

Table 2-1
Summary of BMP Applicability and Implementation from BMP Tables in Appendix A

	BMP Category								
	A. Planning	B. Characterization and/or Remedy Approach	C. Energy/Emissions Transportation	D. Energy/Emissions Equipment Use	E. Materials & Off-site Services	F. Water Resource Use	G. Waste Generation, Disposal, and Recycling	H. Land Use, Ecosystems, and Cultural Resources	I. Safety and Community
Total Number of BMPs	10	9	4	11	5	5	6	7	7
Number of Applicable BMPs	9	8	4	10	4	3	3	3	4
Number of Practical BMPs	8	8	1	4	2	3	3	2	3
Number of BMPs Implemented Prior to GSR Evaluation									
- Fully	5	8	1	3	2	3	3	2	3
- Partially	2	0	0	0	0	0	0	0	0
- Not Yet	1	0	0	1	0	0	0	0	0
Number of Practical BMPs Likely to Result in Cost Savings	4	6	1	4	2	1	3	0	1

2.1.2 Key Findings Regarding BMPs

An overview of key findings regarding application of the BMPs to this pilot project is provided below.

- The Project Team has already considered and implemented many of the GSR BMPs included in Appendix A. Although the Project Team did not explicitly consider these BMPs as part of a GSR evaluation, many of the BMPs have been considered and implemented using sound principles of science and project management. Examples of GSR BMPs already considered or incorporated include (but are not limited to) the following:

    - *Electronic deliverables* - Reports are distributed electronically unless hard copies are requested. For these hard copy deliverables, long appendices such as lab reports are distributed on disc rather than on paper.

    - *Teleconferences in place of meetings* - Calls are conducted in place of meetings whenever possible, usually resulting in meetings only once per year, consisting of site update meetings with client, regulators, and USACE, whose offices are in different cities.

    - *Resource sharing* - The sampling team for this site, which gets to the site from Seattle District via car, does additional sampling at other places on the installation at the same time sampling is performed for this project, which is a form of resource sharing that avoids additional mobilizations.

    - *Perform frequent optimization evaluations* - A series of optimization evaluations have been conducted. Examples of specific optimization evaluations are the recent evaluation of pulse pumping, the FFS representation of a big-picture approach to remedy optimization, and a 2006 optimization of the sampling and change-out of GAC in the treatment plant.

    - *Establish project-specific decision points* - The decision to change the current pump and treat system to an alternative remedy was made based on decreased effectiveness of the current system in removing contaminant mass and reducing contaminant concentrations. For the selected alternative, sampling will be conducted to determine when to transition from pump and treat to bioremediation.

    - *Use existing site structures* - All of the proposed alternatives in the FFS utilize existing infrastructure (wells, treatment building, and infiltration fields). Alternative 4 (regarded as the preferred alternative in the FFS) utilizes the historical washout lagoon for infiltration of amended water in the original source area.

    - *Establish project-specific decision points to limit extent of remediation* - While the cleanup goal for RDX is 2.1 ppb, the FFS assumes it is not practical to target the entire 2.1 ppb plume for active remediation such as in-situ bio, and therefore the in-situ bio is targeting the 20 ppb plume for active remediation (which would hopefully lead to ultimately meeting the cleanup goal throughout most or all of the aquifer over time via other technologies that might include passive approaches).

    - *Reduce engine idle times* - During well drilling, split spoon samples will only be taken in the screen interval, which will reduce drilling idle time.

- *Consider pulse pumping to maximize mass removal* - A pulse pumping optimization evaluation was conducted, and it was determined that pulsing resulted in lower total mass removal than continuous operation.

- *Optimize the amount of material used* - Alternative 4 in the FFS incorporates steps to optimize quantity of corn syrup over time (e.g., reduced injection frequency over time).

- *Use less refined water when possible* - Extracted water is being used for mixing with bio amendments instead of potable water.

- *Use extracted and treated water for beneficial purposes* - Recharge of treated water during P&T is serving a beneficial purpose by replenishing the aquifer, which is already low due to use of water for irrigation, and likely also aids with hydraulic containment of the plume.

- *Minimize investigation derived waste (IDW)* - Low-flow sampling with dedicated bladder pumps is used (reduces purge water), and purge water currently goes through the treatment system and is then recharged to the aquifer.

- *Minimize need to transport hazardous waste* - The GAC loading limits take into account the explosives limits to avoid the spent GAC being hazardous.

- *Recycle materials* - Spent GAC is regenerated.

• While going through the BMP list during the Step 5 call, the GSR Team suggested several items that the Project Team could consider moving forward. Some examples include the following:

  - *Include a section on GSR in reports* - The GSR Team suggests that future reports would benefit from the addition of a section discussing GSR considerations.

  - *Identify GSR concerns of stakeholders* - The GSR Team recommends that the Project Team should document specific concerns of key stakeholders regarding GSR, so that they can be considered and addressed (when feasible) in each phase of the remedial process.

  - *Reduce trip lengths* - The laboratory previously used is in Vicksburg, MS, and the Project Team indicates that the current contract for (semi-annual) compliance sampling is with a Wisconsin-based lab. It seems likely that a lab could be used in Seattle via air or ground transport. The GSR Team recommends that the Project Team evaluate the practicality of using a closer lab such as in Seattle, and evaluate the practicality of air and ground transport for such a lab.

  - *Evaluate use of variable frequency drives (VFDs) on motors* - Extraction well pumps are not currently equipped with VFDs. Since the P&T system under Alternative 4 is only expected to operate for up to 5 years (and perhaps less), the benefits and payback period would need to be considered. This will depend on how much the pump motors are currently throttled back. This has not been fully evaluated because the FFS does not provide details regarding the specific pump motors and throttle positions that would be required to quantify this, but the GSR Team recommends the Project Team evaluate and document the potential use of VFDs on a motor-by-motor basis during system design. The equations required for such an evaluation are included in Table 3-3.

- *Renewable energy* - The tanks for corn syrup require heating. The Project Team is considering using solar power (presumably solar thermal) to heat the holding tanks for corn syrup rather than dropping a power line and the GSR Team recommends this be fully evaluated during the design phase. The tank currently on site used for corn syrup injection pilot testing is painted black to absorb and retain heat.

- The Project Team identified that some BMPs are not practical to implement because of other project-specific constraints. Examples include the following:

  - The Project Team reported that they attempted to find a local source for corn syrup, but the closest practical source that could provide the required quantities is located in Tennessee. Thus, shortening the trip length does not appear to be practical unless another substrate is utilized. The Project Team has indicated that they believe corn syrup is the most effective substrate for remediating the groundwater contamination based on the push-pull tests. However, substrates will be subject to further optimization during implementation of remedial actions.

  - Extracted water could potentially provide heating and cooling via a heat pump. However, the Project Team indicated there is no obvious potential user for the heating and cooling nearby.

  - Off-spec corn syrup (i.e., less refined material and/or re-use of a potential waste product) was considered, but the Project Team identified issues with pH of the substrate in addition to being unable to obtain the necessary quantities of corn syrup from another supplier. Also, the supplier in Tennessee would arrange for transport which was a benefit to the Project Team.

2.2 QUANTITATIVE FOOTPRINT ANALYSIS FOR ALTERNATIVE 4 (BASELINE SCENARIO)

In the Draft Final FFS, Alternative 4 (Pump and Treat Expansion and Bioremediation) was selected as the recommended remedy. This GSR evaluation focuses on Alternative 4 as the "baseline scenario" that is presented in this section of the GSR evaluation report. Potential variations on Alternative 4, that involve modifications to the basic components of Alternative 4, are then discussed in Sections 2.3 to 2.4.

There is a substantial amount of quantitative information provided in Appendix C of the Draft Final FFS for Alternative 4 (which is derived from RACER) and the associated RACER database file provided by the Project Team after the Step 5 call. The GSR Team reviewed that information and developed input to the SiteWise 2.0 tool for quantitative footprinting. A summary of how that information was entered into SiteWise is provided in Appendix B. In some cases, the information in the Draft Final FFS was superseded or clarified by emails from the Project Team, and those are noted in Appendix B.

2.2.1 <u>Overview of Baseline Scenario (Per Year)</u>

For the purposes of costing and footprinting, this alternative is assumed to involve the following components:

- Installation of 2 new extraction wells at the beginning of the 15-year period
- Two injection well tests for in-situ bio (each including installation of a new injection well)
- Continuous P&T with GAC treatment for 5 years using 2 extraction wells, with an additional 3 extraction wells operated periodically
- Injecting corn syrup (8,150 gallons per event) through the existing infiltration gallery at the waste lagoon (the original source area) for 7 days, 3 times per year for 5 years
- 2 extraction wells near the waste lagoon (EW-1 and EW-3) will operate during the 7-day injection period during the first 5 years (this is the water that will be used for the injections)
- The transition to full-scale bioremediation is assumed to occur after 5 years (this transition could potentially occur sooner, and a variation where the transition occurs after only 3 years is presented in Section 2.3)
- 4 new injection wells will be installed for the initial 2 yr bio period after the first five year period is completed; these wells will be utilized as needed during entire 10 year full-scale bio period
- An estimated 4 additional injection wells may subsequently be installed for the following 8 yr bio period to better target areas of high contamination, and are assumed for the GSR evaluation
- 1 existing extraction well will be used as an injection well, and 3 existing extraction wells will be used to encourage distribution of injected substrate during this 10 year period of full-scale bio
- 3 treatment events per year for the first 2 years of full-scale bio, using 262,700 gallons of corn syrup per event. Events will last 30 days, with the system at rest for the following 3 months
- It is assumed that injections will continue at 25% of the original substrate mass 2 times per year for the following 4 years then 1 time per year for an additional 4 years
- O&M and monitoring were costed for a total of 15 years; actual duration of remedial action, O&M and monitoring would be subject to performance evaluations based on measured site data

For cost calculations, the costs each year from the RACER file provided by the Project Team were utilized. Costs identified as capital (no discounting) and annual (no discounting) are based on spreadsheet 'Cost Summary_Alt 4_7-31-11.xlsx' provided by Project Team. The Project Team reported in an email that a 7 percent discount rate was utilized to calculate NPV for the Draft Final FFS.

Note that in SiteWise, vegetable oil was used as a surrogate for corn syrup. In SiteWise, the calculated footprints for materials such as vegetable oil are based on life-cycle inventory database values which are considered to be representative values that account for items such as the growing of the crop, the harvesting of the crop, the transportation of the raw materials for processing, and the processing of the raw materials into the refined material. Also note that nylon tubing for each sampling event was included in the RACER analysis included in the Draft Final FFS, but the Project Team has indicated that dedicated bladder pumps are currently utilized for groundwater monitoring. Therefore, nylon tubing for each event was not included in the SiteWise analysis. The costs of the nylon tubing are minor with respect to the overall remedy, and the costs estimates presented in the Draft Final FFS were not modified.

2.2.2 Summary of Quantitative Footprint Results, Baseline Scenario

Table 2-2 summarizes the quantitative footprint results for the current system over the 15-year remedy duration. Input to the SiteWise tool and other supporting calculations are described in Appendix B. The SiteWise files utilized for this portion of the analysis are supplied electronically (SiteWise directory "RA_Baseline_NoFR_1").

Table 2-2 divides total energy use and global warming potential into "direct" and "indirect" use and emissions. The following definitions are utilized for "direct" versus "indirect" energy use and global warming potential:

- Direct Scope 1: From sources that are owned or controlled by the reporting entity.
- Indirect Scope 2: Due to activities of the reporting entity, but occur at sources owned or controlled by another entity, from consumption of purchased electricity, heat or steam.
- Indirect Scope 3: Due to activities of the reporting entity, but occur at sources owned or controlled by another entity, other than Scope 2 (such as the extraction and production of purchased materials and fuels, transport-related activities in vehicles not owned or controlled by the reporting entity, outsourced activities, waste disposal, etc.

SiteWise reports total energy use and total global warming potential, but does not split the "direct" and "indirect" components. The user needs to track the distinction between "direct" and "indirect" components separately, based on information contained within the SiteWise spreadsheets. The separation of the total energy and global warming potential is documented in Appendix B, which describes SiteWise input and related calculations.

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Table 2-2
Summary of Quantitative Footprint for Alternative 4 (Baseline)

GSR Parameter	Unit	Value (15-Year Total)
Environmental		
Energy – Total	MMBtu	102,851
Energy – Direct Scope 1	MMBtu	9,650
Energy – Indirect Scope 2	MMBtu	18,480
Energy – Indirect Scope 3	MMBtu	74,721
% of Energy from Renewable Resources	%	13.5%
Global warming potential – Total	Metric tons CO2e	5,192
Global warming potential – Direct Scope 1	Metric tons CO2e	32
Global warming potential – Indirect Scope 2	Metric tons CO2e	1,186
Global warming potential – Indirect Scope 3	Metric tons CO2e	3,974
Criteria air pollutant emissions	Metric tons (NOx+SOx+PM)	21.6
Hazardous air pollutant emissions	Lb	0
Potable water use	1,000s of gallons	1,367
Other water use	1,000s of gallons	Negligible
Refined materials use	Lbs	16,975,069
% of refined materials from recycled material	%	0
Unrefined materials use	Ton	580
% of unrefined materials from recycled material	%	0
Non-hazardous waste generation	Ton	175
Hazardous waste generation	Ton	0
% of potential waste that is recycled or re-used	%	38%
Land transferred or made available for beneficial use	Acres	0
Existing ecosystem destruction	Acres	Not quantified
Time frame for land re-use	Years	Not determined
Flexibility and breadth of options for re-use	see below*	Not determined
Economic		
Life-cycle Cost, Discounted (7% discount rate)	$	$14.3 M**
Life-cycle Cost, Undiscounted	$	$19.7 M
Capital Cost	$	$13.3 M**
Societal		
Predicted number of injuries or fatalities for On-Site Worker	Number of injuries or fatalities	0.005
Predicted number of injuries or fatalities associated with transportation	Number of injuries or fatalities	0.198
One-Way Heavy Vehicle Trips through Res. Area	Trips	None

**Scale for flexibility and breadth of re-use options (greater GSR value with lower number, indicating more breadth and flexibility for potential re-use)*

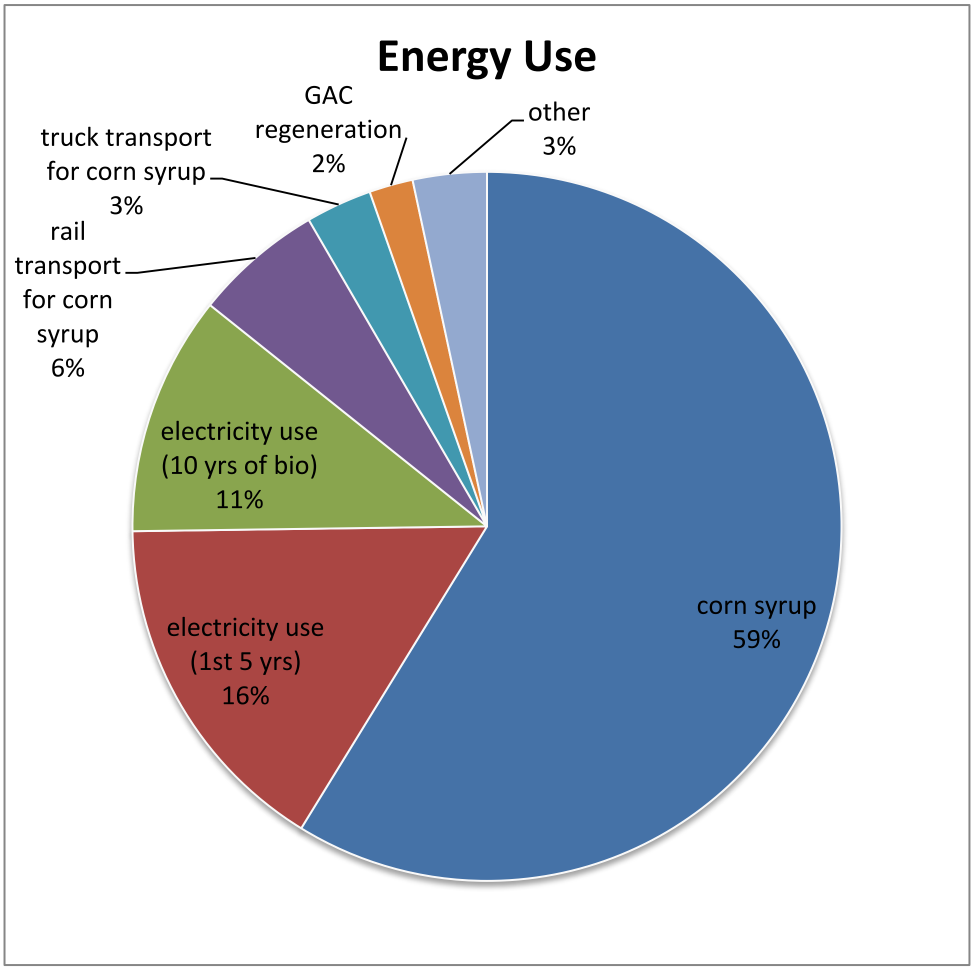
1 - Unlimited re-use options
2 - Limited re-use options
3 - Only one re-use option

*** Costs identified as capital (no discounting) and annual (no discounting) are based on spreadsheet 'Cost Summary_Alt 4_7-31-11.xlsx' provided by Project Team, which summarizes RACER results. See cost sheet included in Appendix B for more information.*

2.2.3 Key Findings from Quantitative Footprint Analysis, Baseline Scenario

Observations and finding based on the quantitative footprinting results from SiteWise include the following:

- The primary contributors to total energy use for Alternative 4 (Baseline) are illustrated on the graphic below and are summarized as follows:



  - Corn syrup production requires an estimated 60,454 MMBtus (59% of total energy use)
    - Most energy use is associated with the corn syrup used for the first two years of full scale bio (35,812 MMBtus)
    - The next most is associated with the corn syrup used for the final 8 years of full scale bio (19,906 MMBtus)
    - The rest is associated with the injection tests and the limited bio during the first 5 years (6,735 MMBtus)

  - Electricity use listed in RACER for the first 5 years of P&T operation requires an estimated 16,460 MMBtus (16% of total energy use)

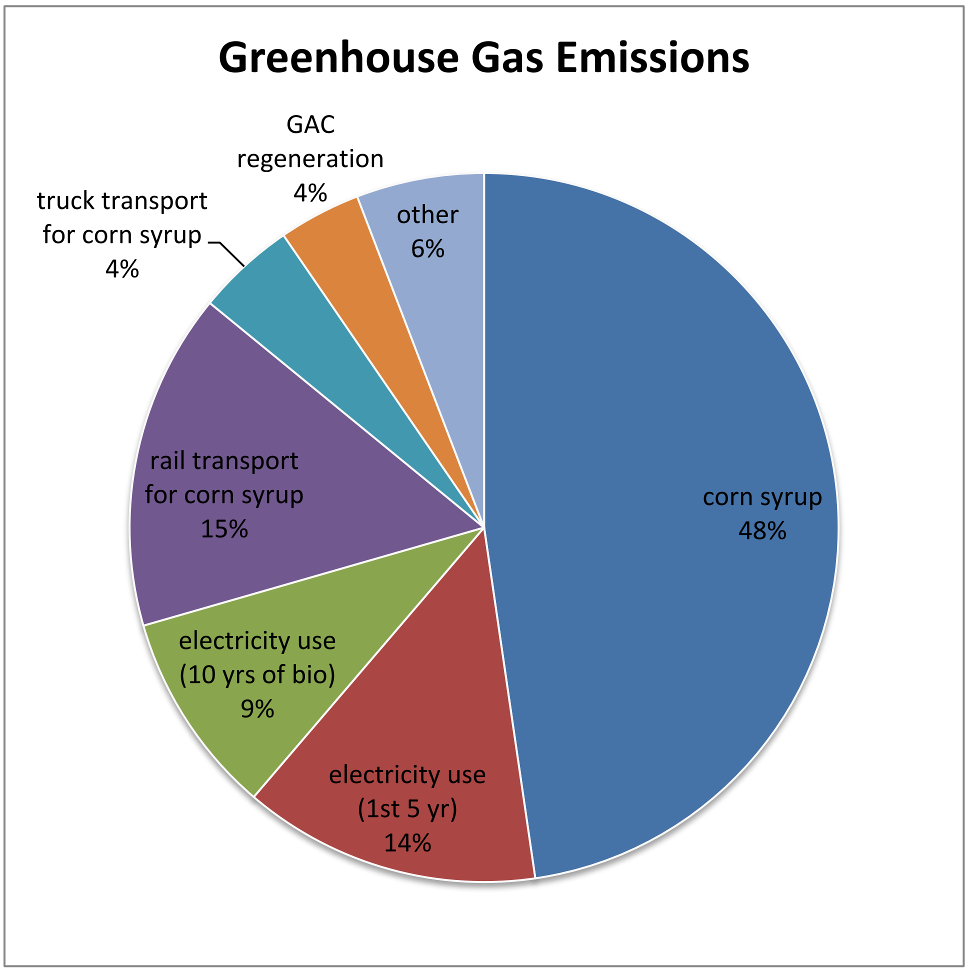
- Electricity use listed in RACER for the subsequent 10 years of bioremediation requires an estimated 11,260 MMBtus (11% of total energy use)

- Rail transport of the corn syrup from Tennessee to Seattle, calculated in SiteWise based on the weight of the material and the transport distance (to account for the fact that it shares the train with other items), requires an estimated 6,055 MMBtus (6% of total energy use)

- Truck transport of the corn syrup from Seattle to Umatilla requires an estimated 3,102 MMBtus (3% of total energy use)

- Production/regeneration of GAC for the 5 years of P&T operation requires an estimated 2,055 MMBtus (2% of total energy use)

• The primary contributors to global warming potential for Alternative 4 (Baseline) are illustrated on the graphic below and are summarized as follows:



- Corn syrup production generates an estimated 2,476 Metric tons of CO2e (48% of total greenhouse gas emissions)
  - Most CO2e is associated with the corn syrup used for the first two years of full scale bio (1,467 Metric tons of CO2e)

        - The next most is associated with the corn syrup used for the final 8 years of full scale bio (733 Metric tons of CO_2e)
        - The rest is associated with the injection tests and the limited bio during the first 5 years (276 Metric tons of CO_2e)

    - Electricity use listed in RACER for the first 5 years of P&T operation generates an estimated 704 Metric tons of CO_2e (14% of total energy use)

    - Rail transport of the corn syrup from Tennessee to Seattle, calculated in SiteWise based on the weight of the material and the transport distance (to account for the fact that it shares the train with other items), generates an estimated 799 Metric tons of CO_2e (15% of total energy use)

    - Electricity use listed in RACER for the subsequent 10 years of bioremediation generates an estimated 482 Metric tons of CO_2e (9% of total energy use)

    - Truck transport of the corn syrup from Seattle to Umatilla generates an estimated 234 Metric tons of CO_2e (5% of total energy use)

    - Production/regeneration of GAC for the 5 years of P&T operation generates an estimated 194 Metric tons of CO_2e (4% of total energy use)

- With respect to the energy use and greenhouse gas emissions, the vast majority (on the order of 75 to 80%) are "Indirect Scope 3", because they are associated with off-site generation of materials and transportation of materials and personnel. The next greatest contributors are "Indirect Scope 2" associated with off-site generation of electricity. Thus, there is only limited contribution from direct on-site activities.

- With respect to % energy from renewable sources, according to eGRID (http://cfpub.epa.gov/egridweb/view_srl.cfm), the percentage of electricity from renewable sources for region Northwest Power Pool Area (NWPP) sub-region of the Western Electric Coordinating Council (which is the applicable region for this site) is 50.93% (most of which is hydropower). Thus, it is assumed that 50.93% of the on-site electricity use is from renewable resources. The on-site electrical use is estimated at 27,720 MMBtu in SiteWise. The total energy use (on-site and off-site) is estimated at 102,851 MMBtu. Assuming all fuels used and all other energy use for production of materials are from non-renewable sources, then the % of total energy from renewable sources is approximately 13.7%.

- The total criteria pollutant emissions (NOx plus SOx plus PM) are approximately 21.6 Metric tons. The majority calculated by SiteWise is for the rail transportation of the corn syrup, and to a lesser extent the electricity usage. It is important to note, however, that SiteWise does not calculate criteria pollutant emissions for materials production, which was the dominant contributor for energy use and greenhouse gas emissions (for production of corn syrup).

- Alternative 4 uses only a small amount of potable water which is associated with the off-site production of electricity.

- Refined materials use is dominated by corn syrup, as summarized below:

    - 16,543,116 lbs corn syrup

- o 214,335 lbs GAC
- o 124,074 lbs concrete
- o 41,201 lbs cement
- o 26,589 lbs stainless steel
- o 3,616 lbs HDPE pipe
- o 758 lbs Steel (not stainless)

- Unrefined materials use consists primarily of gravel for backfill (576 tons), and a small amount for well filter pack (4 tons)

- The non-hazardous waste (175 tons) is based on shipping of drums estimated in RACER. It appears this is intended to represent off-site disposal of purge water, though this may also represent a simplification within RACER.

- The % of potential waste that is recycled or re-used (38%) is due to regeneration of used GAC during the first five years.

- The total costs are dominated by capital costs, which occur at several times during the remedy (see cost sheet in Appendix B):

    - o Year 0: capital costs of $4.1 M
    - o Year 1: capital costs of $0.4 M
    - o Year 4: capital costs of $0.5M
    - o Year 5: capital costs of $5.2M
    - o Year 7: capital costs of $3.0 M

2.3 QUANTITATIVE FOOTPRINT ANALYSIS FOR VARIATION 1 - INITIAL P&T AND IN-SITU BIO AT WASTE LAGOON FOR 3 YEARS INSTEAD OF 5 YEARS

2.3.1 Overview of Variation 1

Alternative 4 in the Draft Final FFS was costed (and footprinted in Appendix B) assuming an enhanced version of the current P&T system coupled with bioremediation at the waste lagoon for an initial period of 5 years, with full-scale bioremediation thereafter for 10 years. However, it was also stated in the Draft Final FFS that actual duration of remedial action, O&M and monitoring would be subject to performance evaluations based on measured site data. The variation described here is based on the potential transition to a system with no P&T and full-scale bioremediation after 3 years of expanded P&T with limited bioremediation based on remedy performance and measured site data. Note that for the purposes of SiteWise input, it is assumed that transitioning from the initial phase to full-scale bioremediation 2 years earlier will lead to a 2 year decrease in overall remedy duration from the baseline (i.e. full-scale bio will still last for 10 years), for a total remedy duration of 13 years. For this variation on Alternative 4, SiteWise inputs are based on the SiteWise inputs for the Alternative 4 Baseline (included in Appendix B of this report), but changes are made to some quantities to account for only 3 years of the initial enhanced P&T system with limited bioremediation (the amount of substrate and transportation of that substrate is reduced by 40% versus the baseline). Capital costs for the substrate and transportation of the substrate, which are treated as capital costs in year 0 in the RACER analysis performed by the Project Team, are also reduced by 40% versus the baseline (note this represents just a portion of the overall capital costs in year 0). Capital costs for the capital items after the initial year are moved up two years, and annual costs for the last 2 years of the initial phase are eliminated.

2.3.2 Summary of Quantitative Footprint Results for Variation 1 versus Baseline

Table 2-3 summarizes the footprint results for Variation 1 compared to the results for Alternative 4 (Baseline). Input to the SiteWise tool and other supporting calculations for Variation 1 are described in Appendix C1. A cost spreadsheet is also included in Appendix C1.

Table 2-3
Summary of Quantitative Footprint for Alternative 4 (Baseline) versus Variation 1 (Initial Phase Only 3 Yrs)

GSR Parameter	Unit	Alternative 4 Value (Baseline, 15-Year Total)	Variation 1 Value (Initial Phase Only 3 Yrs, 13-Year Total)
Environmental			
Energy – Total	MMBtu	102,851	92,789
Energy – Direct Scope 1	MMBtu	9,650	7,455
Energy – Indirect Scope 2	MMBtu	18,480	14,091
Energy – Indirect Scope 3	MMBtu	74,721	71,243
% of Energy from Renewable Resources	%	13.7%	11.6%
Global warming potential – Total	Metric tons CO2e	5,192	4,688
Global warming potential – Direct Scope 1	Metric tons CO2e	32	32
Global warming potential – Indirect Scope 2	Metric tons CO2e	1,186	904
Global warming potential – Indirect Scope 3	Metric tons CO2e	3,974	3,752
Criteria air pollutant emissions	Metric tons (NOx+SOx+PM)	21.6	20.1
Hazardous air pollutant emissions	Lb	0	0
Potable water use	1,000s of gallons	1,367	1,042
Other water use	1,000s of gallons	Negligible	Negligible
Refined materials use	Lbs	16,975,069	16,312,315
% of refined materials from recycled material	%	0	0
Unrefined materials use	Ton	580	580
% of unrefined materials from recycled material	%	0	0
Non-hazardous waste generation	Ton	175	169
Hazardous waste generation	Ton	0	0
% of potential waste that is recycled or re-used	%	38%	28%
Land transferred or made available for beneficial use	Acres	0	0
Economic			
Life-cycle Cost, Discounted (7% discount rate)	$	$14.3 M*	$14.2 M*
Life-cycle Cost, Undiscounted	$	$19.7 M	$18.2 M
Capital Cost	$	$13.3 M*	$13.0 M*
Societal			
Predicted number of injuries or fatalities for On-Site Worker	Number of injuries or fatalities	0.005	0.005
Predicted number of injuries or fatalities associated with transportation	Number of injuries or fatalities	0.198	0.172
One-Way Heavy Vehicle Trips through Res. Area	Trips	None	None

** NPV based on cost spreadsheets in Appendix B (Baseline) and Appendix C1 (Variation 1). For Variation 1, capital costs after initial year are moved up 2 years, and 4th and 5th years of Annual Costs are eliminated.*

2.3.3 Primary Footprints That Would Improve for Variation 1

The following key footprints would improve in this variation versus the baseline:

- Energy use declines by 10,062 MMBTU (~10% decrease for entire remedy duration)
- Global warming potential declines by 504 Metric tons of CO_2e (~10% for entire remedy duration)
- Criteria air pollutant emissions decline by 1.5 Metric tons (~7% for entire remedy duration)
- Refined material use associated with corn syrup declines by 662,754 pounds (~4% for entire remedy duration)
- Non-hazardous waste generation included in RACER would decline by 6 tons (~3% for entire remedy duration)
- Non-discounted capital costs decrease approximately $0.3M due to reduction in the capital cost of bioremediation substrate (and associated transport/injection of the substrate) in the first five years (assigned as capital cost in Year 0 of the RACER analysis)
- Non-discounted life-cycle costs decline by $1.5M due to elimination of 2 years of O&M for the P&T system as well as the reduction in capital cost of bioremediation substrate (and associated transport of the substrate) in the first five years
- The discounted life-cycle cost only improves slightly (approximately $0.1M) despite the two years of eliminated annual costs and lower capital costs for the bioremediation substrate. The improvement is minimal because significant capital costs for the overall remedy are moved up two years, and 10 years of subsequent annual costs are also moved up two years. Because the discount rate selected by the Project Team of 7% is a fairly high value, the fact that so much cost is accelerated by two years results in just a slight decrease in life-cycle cost.
- Injuries associated with transportation decline slightly due to reduced travel by the O&M operator

2.3.4 Primary Footprints That Would Worsen for Variation 1

The percentage of energy from renewable resources calculated by the GSR Team decreases because a high percentage of electricity used is from renewable energy and electrical use is reduced in this variation. However, this is somewhat misleading because there is actually a net benefit from reduced energy usage in this variation. Similarly, the percentage of potential waste that is recycled or re-used decreases slightly in this variation because less GAC is regenerated. Again, this is misleading because the net reduction in GAC usage is actually a net benefit.

2.4 QUANTITATIVE FOOTPRINT ANALYSIS FOR VARIATION 2 - SHIP LAB SAMPLES TO CLOSER LAB

2.4.1 Overview of Variation 2

This variation on the baseline for Alternative 4 involves using a closer facility for laboratory analysis of collected samples. For the baseline footprinting, it is assumed that all samples are sent via air to ERDC in Vicksburg, MS, which has been used in the past for this site. The ERCD lab in MS has been used for pilot testing; but other accredited labs are used for compliance sampling. The Project Team indicates that the current contract for (semi-annual) compliance sampling is with a Wisconsin-based lab; and because WI and MS are roughly the same distance from Seattle (+/- 25%) the transport cost assumptions used in this evaluation are likely reasonable.

The footprint for lab shipments could be reduced if a closer lab was used. For quantifying an approximate footprint reduction for Variation 2, it is assumed that a lab in Seattle (~185 miles one-way) will be used to analyze all samples. Two possibilities were evaluated with SiteWise:

- Variation 2A - Assume that samples sent to Seattle will still be shipped overnight via air (FEDEX), calculated in SiteWise based on the weight of the material and the transport distance (to account for the fact that it shares the airplane with other items). Only the air portion is compared; the transport of the samples to and from the airports was not quantified (would likely be similar in both cases).

- Variation 2B – Assume samples sent to Seattle will still be shipped by ground (via FEDEX ground). Assume shipment represents 10% of a shared vehicle, so reduce mileage entered into SiteWise by 90% in all cases to account for the fact that only 10% of vehicle emissions would be caused by this shipment.

Costs were not evaluated in detail, but it is assumed that ground transportation to Seattle (Variation 2B) would have the lowest cost, and air transport to Seattle (Variation 2A) would have lower cost than the Baseline. The Project Team notes the following: "Normally this would be a reasonable assumption, but for compliance monitoring the lowest-cost lab was in Wisconsin even though a cost proposal was received from a Seattle-area lab. Current contract criteria call for 'lowest cost bid which is technically acceptable.' FEDEX transport costs (at least under USACE account utilized for sample shipment) to the lab are based on weight of shipment and not on transport distance or whether it went via air or ground. Therefore, in order for GSR considerations like reduced greenhouse gas emissions to be considered, they would need to be written into contracts (which may not even be possible with overnight shipping companies) and would not always result in lower cost."

2.4.2 Summary of Quantitative Footprint Results for Variation 2 versus Baseline

Table 2-4 summarizes the footprint results for Variation 2 compared to the results for Alternative 4 (baseline). Input to the SiteWise tool and other supporting calculations for Variation 2 are described in Appendix C2.

Table 2-4
Summary of Quantitative Footprint for Lab Shipments in Alternative 4 (Baseline) Versus Lab Shipments in Variation 2 (Closer Lab)

GSR Parameter	Unit	Baseline Lab Shipments (Vicksburg - Air)	Variation 2A Lab Shipments (Seattle - Air)	Variation 2B Lab Shipments (Seattle - Ground)
Environmental				
Energy – Total	MMBtu	341	35	52
Global warming potential – Total	Metric tons CO2e	48.8	5.0	4.0
Criteria air pollutant emissions	Metric tons (NOx+SOx+PM)	0.164	0.017	0.001

2.4.3 Primary Footprints That Would Improve for Variation 2

The following key footprints would improve in this variation versus the baseline:

- The total energy use for transport to the lab declines versus the baseline on the order of 90% with either air transport or ground transport to Seattle.
- The global warming potential for transport to the lab declines versus the baseline on the order of 90% with either air transport or ground transport to Seattle.
- The criteria air pollutants for transport to the lab declines versus the baseline by approximately 90% for air transport to Seattle, and by more than 99% for vehicle transport to Seattle.

Note that the footprints for the lab shipments represent a small component of the overall remedy footprint. For instance, the greenhouse gas footprint for lab shipments in the baseline (48.8 Metric tons of CO2e) represents approximately 1% of the greenhouse gas footprint for the entire remedy.

2.4.4 Primary Footprints That Would Worsen for Variation 2

None.

2.5 OTHER QUALITATIVE CONSIDERATIONS

None.

3.0 GSR RECOMMENDATIONS

These are recommendations provided by the GSR Team for the consideration of the Project Team, and potentially other project stakeholders. These are not requirements, and implementation should ultimately be decided by the Project Team based on their concurrence regarding GSR benefits and/or other project-specific constraints.

GSR recommendations are summarized in the form of tracking tables, as follows:

Table Number	Recommendation
3-1	3.1 - Evaluate practicality of a closer lab
3-2	3.2 - Update GSR footprinting during design to improve RACER simplifications
3-3	3.3 - Evaluate use of variable frequency drives (VFDs) on motors during design
3-4	3.4 - Evaluate solar thermal for heating corn syrup tanks during design
3-5	3.5 - Include a section on GSR in reports
3-6	3.6 - Identify GSR concerns of stakeholders

The tracking table format allows the implementation status of the recommendation to be updated as the project progresses.

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Table 3-1
Tracking Table for Recommendation 3.1

<table>
<tr><td colspan="2">Recommendation:

3.1 - Evaluate practicality of a closer lab</td><td>Current Date:
2/7/12

Date of Original Recommendation:
2/7/12</td></tr>
<tr><td colspan="3">Basis for Recommendation (Include discussion of cost impacts and value if appropriate):

For the baseline footprinting, it is assumed that all samples are sent via air to ERDC in Vicksburg, MS, which has been used in the past for this site (similar distance as to Wisconsin lab that has also been utilized). However, the footprint for lab shipments could be reduced if a closer lab was used (e.g., Seattle via air or ground).</td></tr>
<tr><td colspan="3">Resources Conserved:
☐ Hazardous air pollutants ☒ GHG emissions (CO2e) ☒ Energy ☐ Water ☐ Waste
☒ Criteria pollutants ☐ Safety/Community ☐ Materials ☐ Land-use</td></tr>
<tr><td>Qualitative Net Cost Impact Over 5 Years, No Discounting

☐ Cost Increase ☒ Cost Savings
☐ Cost Neutral ☐ N/A</td><td colspan="2">☐ Recommended action otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="3">Attachment(s) to report with footprint assumptions and calculations:

See Appendix C2 and discussion in Section 2.4 of this of this GSR evaluation report. Compared to air transport to Vicksburg (the baseline), the footprint evaluation suggests that energy use and global warming potential associated with the transport to the lab will decline approximately 90% with either air transport or ground transport to Seattle. The criteria air pollutants decline versus the baseline by approximately 90% for air transport to Seattle, and by more than 99% for vehicle transport to Seattle.

Costs were not evaluated in detail, but it is assumed that ground transportation to Seattle would have the lowest cost, and air transport to Seattle would have a lower cost than the Baseline. The Project Team notes the following: "Normally this would be a reasonable assumption, but for compliance monitoring the lowest-cost lab was in Wisconsin even though a cost proposal was received from a Seattle-area lab. Current contract criteria call for 'lowest cost bid which is technically acceptable.' FEDEX transport costs (at least under USACE account utilized for sample shipment) to the lab are based on weight of shipment and not on transport distance or whether it went via air or ground. Therefore, in order for GSR considerations like reduced greenhouse gas emissions to be considered, they would need to be written into contracts (which may not even be possible with overnight shipping companies) and would not always result in lower cost."</td></tr>
<tr><td>Implementation Status:

☐ Fully
☒ Partially
☐ Not Yet
☐ Not Planned</td><td colspan="2">Explanation of Status:

The Project Team indicated they are looking into alternate laboratory locations but have not yet made any decisions.</td></tr>
</table>

Table 3-2
Tracking Table for Recommendation 3.2

<table>
<tr><td colspan="2">Recommendation:

3.2 - Update GSR footprinting during design to improve RACER simplifications</td><td>Current Date:
2/7/12

Date of Original Recommendation:
2/7/12</td></tr>
<tr><td colspan="3">Basis for Recommendation (Include discussion of cost impacts and value if appropriate):

This GSR evaluation as performed during the "FS Stage" is based on estimates in RACER, many of which may be simplifications. Simplifications might include quantity of materials, amount of non-hazardous waste, estimates of labor and trips required, etc., and better estimates will be available during detailed system design.</td></tr>
<tr><td colspan="3">Resources Conserved:
☐ Hazardous air pollutants ☐ GHG emissions (CO2e) ☐ Energy ☐ Water ☐ Waste
☐ Criteria pollutants ☐ Safety/Community ☐ Materials ☐ Land-use</td></tr>
<tr><td colspan="2">Qualitative Net Cost Impact Over 5 Years, No Discounting

☐ Cost Increase ☒ Cost Savings
☐ Cost Neutral ☐ N/A</td><td>☐ Recommended action otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☒ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="3">Attachment(s) to report with footprint assumptions and calculations:

This is a qualitative recommendation. Cost impacts checked above are "assumed".</td></tr>
<tr><td>Implementation Status:

☐ Fully
☐ Partially
☒ Not Yet
☐ Not Planned</td><td colspan="2">Explanation of Status:

This is an inherent issue in doing a GSR evaluation in the FS phase. Although there is value in doing a GSR evaluation before all details are finalized, so that findings can be considered during remedy selection, such uncertainties can be addressed in more detail if GSR footprinting is updated during the design phase, when more precise quantities for various items (labor, materials, etc.) are estimated.</td></tr>
</table>

Table 3-3
Tracking Table for Recommendation 3.3

<table>
<tr><td colspan="2">Recommendation:

3.3 - Evaluate use of variable frequency drives (VFDs) on motors during design</td><td>Current Date:
2/7/12

Date of Original Recommendation:
2/7/12</td></tr>
<tr><td colspan="3">Basis for Recommendation (Include discussion of cost impacts and value if appropriate):

Extraction well pumps are not currently equipped with VFDs. Since the P&T system under Alternative 4 is only expected to operate for up to 5 years (and perhaps less), the benefits and payback period would need to be considered. This will depend on how much the pump motors are currently throttled back. This has not been fully evaluated because the FFS does not provide details regarding the specific pump motors and throttle positions that would be required to quantify this, but the GSR Team recommends the Project Team evaluate and document the potential use of VFDs on a motor-by-motor basis during system design.</td></tr>
<tr><td colspan="3">Resources Conserved:
☐ Hazardous air pollutants ☒ GHG emissions (CO2e) ☒ Energy ☐ Water ☐ Waste
☒ Criteria pollutants ☐ Safety/Community ☐ Materials ☐ Land-use</td></tr>
<tr><td>Qualitative Net Cost Impact Over 5 Years, No Discounting

☐ Cost Increase ☒ Cost Savings
☐ Cost Neutral ☐ N/A</td><td colspan="2">☐ Recommended action otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☒ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="3">Attachment(s) to report with footprint assumptions and calculations:

No detailed footprinting was performed by the GSR Team, since that would require more detailed information regarding each pump (HP, throttle position). Cost impacts checked above are "assumed".</td></tr>
<tr><td>Implementation Status:

☐ Fully
☐ Partially
☒ Not Yet
☐ Not Planned</td><td colspan="2">Explanation of Status:

During the design phase of this project, the GSR Team recommends that the Project Team more clearly define the actual pump motors (HP, usage time, throttle position of non-VFD motors, etc.) and other assumptions used to develop the estimates for electrical usage. Note that power to operate pumps is proportional to the cube of the pump or blower speed. Based on this relationship, the following equation is used to estimate the electricity used by a motor with a VFD.

$$HP_{eff} = \frac{HP \times L_V^{\,3}}{\eta_v}$$
HP_{eff} = effective horsepower for pump operated with VFD to enter into SiteWise (includes efficiency of VFD)
HP = rated horsepower of motor
L_V = % of VFD full load (or speed in Hertz divided by 60 Hertz)
η_v = efficiency of VFD (80% for VFD speed settings of approximately 50% to 75% of full speed)
For VFDs in SiteWise, enter 100% for pump load because the pump load is integral to the L_v parameter and use the default or otherwise appropriate motor efficiency.</td></tr>
</table>

Table 3-4
Tracking Table for Recommendation 3.4

<table>
<tr><td colspan="2" rowspan="2">Recommendation:

3.4 - Evaluate solar thermal for heating corn syrup tanks during design</td><td>Current Date:
2/7/12</td></tr>
<tr><td>Date of Original Recommendation:
2/7/12</td></tr>
<tr><td colspan="3">Basis for Recommendation (Include discussion of cost impacts and value if appropriate):

The tanks for corn syrup require heating. The Project Team is considering using solar power (presumably solar thermal) to heat the holding tanks for corn syrup rather than dropping a power line and the GSR Team recommends this be fully evaluated during the design phase.</td></tr>
<tr><td colspan="3">Resources Conserved:
☐ Hazardous air pollutants ☒ GHG emissions (CO2e) ☒ Energy ☐ Water ☐ Waste
☒ Criteria pollutants ☐ Safety/Community ☐ Materials ☐ Land-use</td></tr>
<tr><td colspan="2">Qualitative Net Cost Impact Over 5 Years, No Discounting
☐ Cost Increase ☐ Cost Savings
☐ Cost Neutral ☐ N/A</td><td>☐ Recommended action otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="3">Attachment(s) to report with footprint assumptions and calculations:

No detailed footprinting was performed by the GSR Team. The footprint would require more information regarding the number of tanks, the detailed specifications of the tanks and heating requirements, the cost of running electricity to those tanks, etc. These data should be available during the design phase, at which point a footprinting evaluation (including cost comparison) would be appropriate. The cost boxes are not checked above because it is not clear at this time what the up-front costs would be for running electricity and using electric heating, versus the up-front costs and electric savings for the solar.</td></tr>
<tr><td>Implementation Status:

☐ Fully
☐ Partially
☒ Not Yet
☐ Not Planned</td><td colspan="2">Explanation of Status:

This is a new recommendation for the Project Team to consider.</td></tr>
</table>

Table 3-5
Tracking Table for Recommendation 3.5

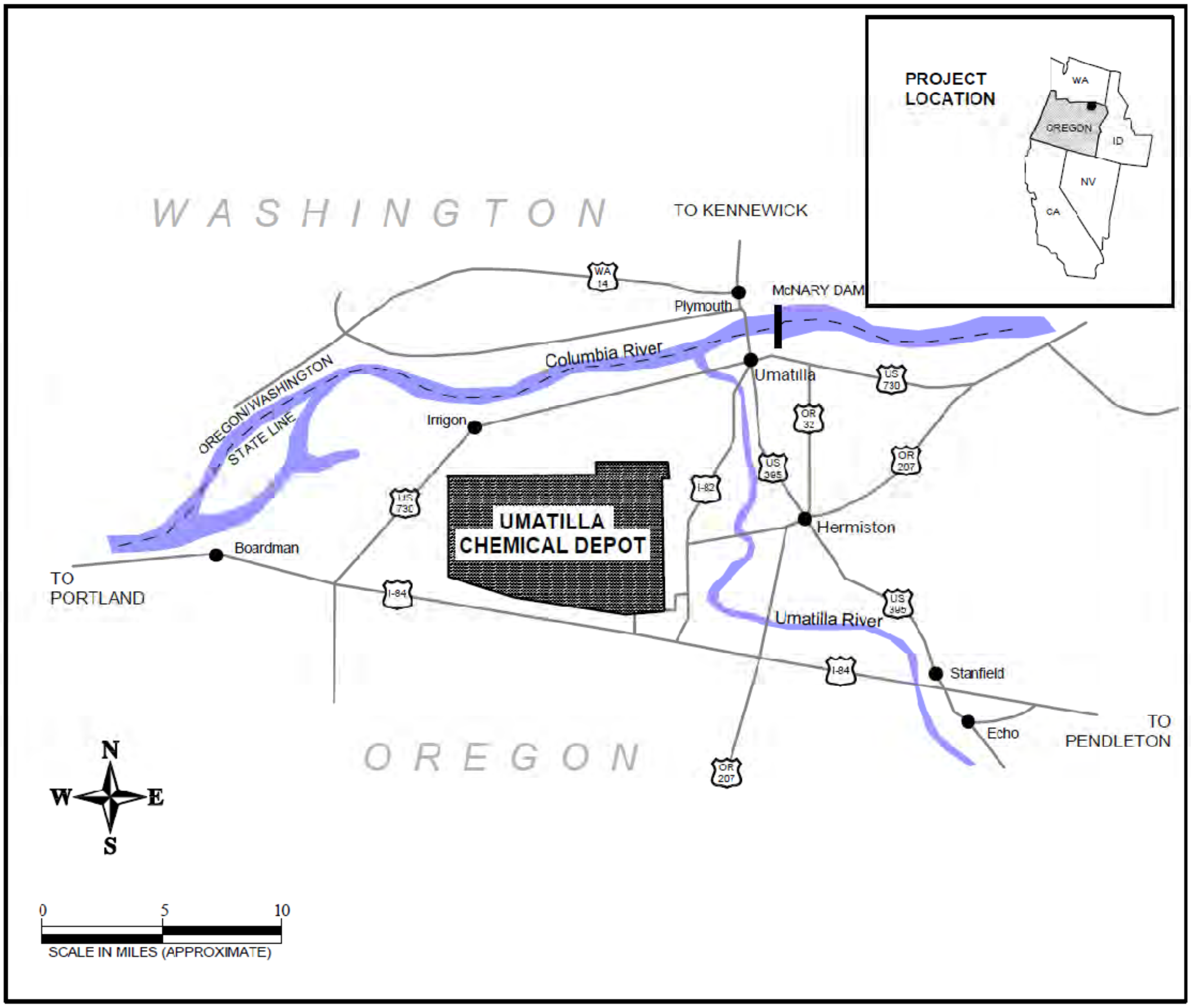
Recommendation: *3.5 - Include a section on GSR in reports*	Current Date: 2/7/12 Date of Original Recommendation: 2/7/12
Basis for Recommendation (Include discussion of cost impacts and value if appropriate): *The GSR Team suggests that future reports would benefit from the addition of a section discussing GSR considerations.*	
Resources Conserved: ☐ Hazardous air pollutants ☐ GHG emissions (CO2e) ☐ Energy ☐ Water ☐ Waste ☐ Criteria pollutants ☐ Safety/Community ☐ Materials ☐ Land-use	
Qualitative Net Cost Impact Over 5 Years, No Discounting ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A	☐ Recommended action otherwise required? If checked, required by:
Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000	
Attachment(s) to report with footprint assumptions and calculations: *This is a qualitative recommendation, and no detailed footprinting was performed.*	
Implementation Status: ☐ Fully ☐ Partially ☒ Not Yet ☐ Not Planned	Explanation of Status: *This is a new recommendation for the Project Team to consider.*

Table 3-6
Tracking Table for Recommendation 3.6

Recommendation: *3.6 - Identify GSR concerns of stakeholders*	Current Date: 2/7/12 Date of Original Recommendation: 2/7/12
Basis for Recommendation (Include discussion of cost impacts and value if appropriate): *The GSR Team recommends that the Project Team document specific concerns of key stakeholders regarding GSR, so that they can be considered and addressed (when feasible) in each phase of the remedial process.*	
Resources Conserved: ☐ Hazardous air pollutants ☐ GHG emissions (CO2e) ☐ Energy ☐ Water ☐ Waste ☐ Criteria pollutants ☐ Safety/Community ☐ Materials ☐ Land-use	
Qualitative Net Cost Impact Over 5 Years, No Discounting ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A	☐ Recommended action otherwise required? If checked, required by:
Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < \$10,000 ☐ \$10,001 - \$50,000 ☐ \$50,001 - \$100,000 ☐ \$100,001 - \$500,000 ☐ > \$500,000	
Attachment(s) to report with footprint assumptions and calculations: *This is a qualitative recommendation, and no detailed footprinting was performed.*	
Implementation Status: ☐ Fully ☒ Partially ☐ Not Yet ☐ Not Planned	Explanation of Status: *This is a new recommendation for the Project Team to consider. "Partially" is checked to acknowledge that the Project Team already has a good understanding of general stakeholder concerns. The recommendation is to attempt to specifically understand the GSR-related concerns of site stakeholders.* `

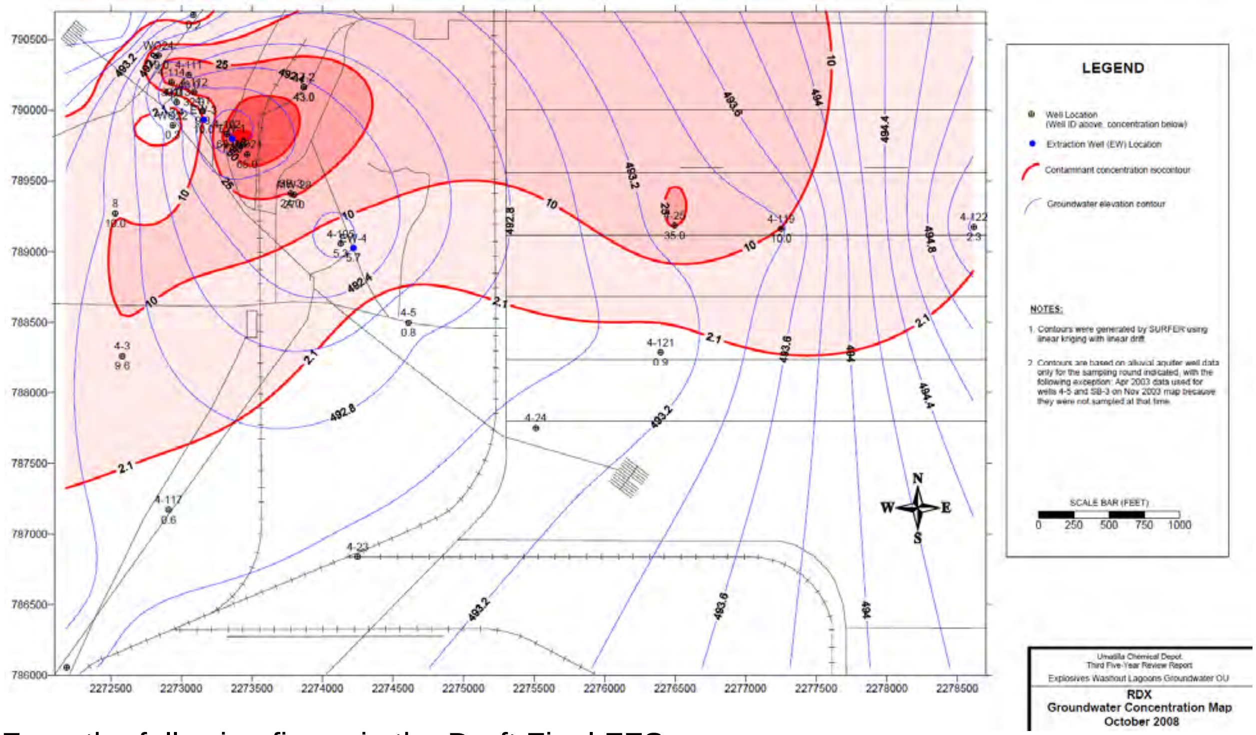
FIGURES

Figure 1-1. Location of Umatilla Chemical Depot



From the following figure in the Draft Final FFS:
FIGURE 1-1. UMATILLA CHEMICAL DEPOT, VICINITY MAP.

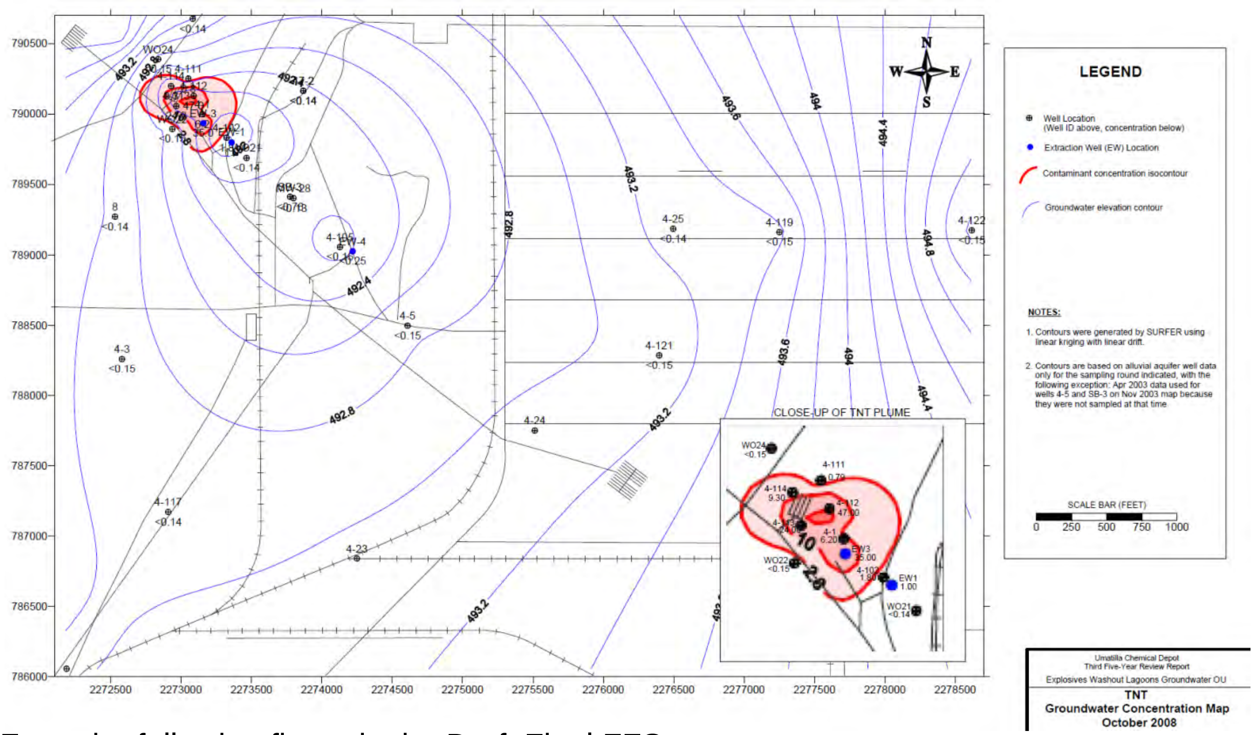
Figure 1-2. RDX Plume, Fall 2008



From the following figure in the Draft Final FFS:

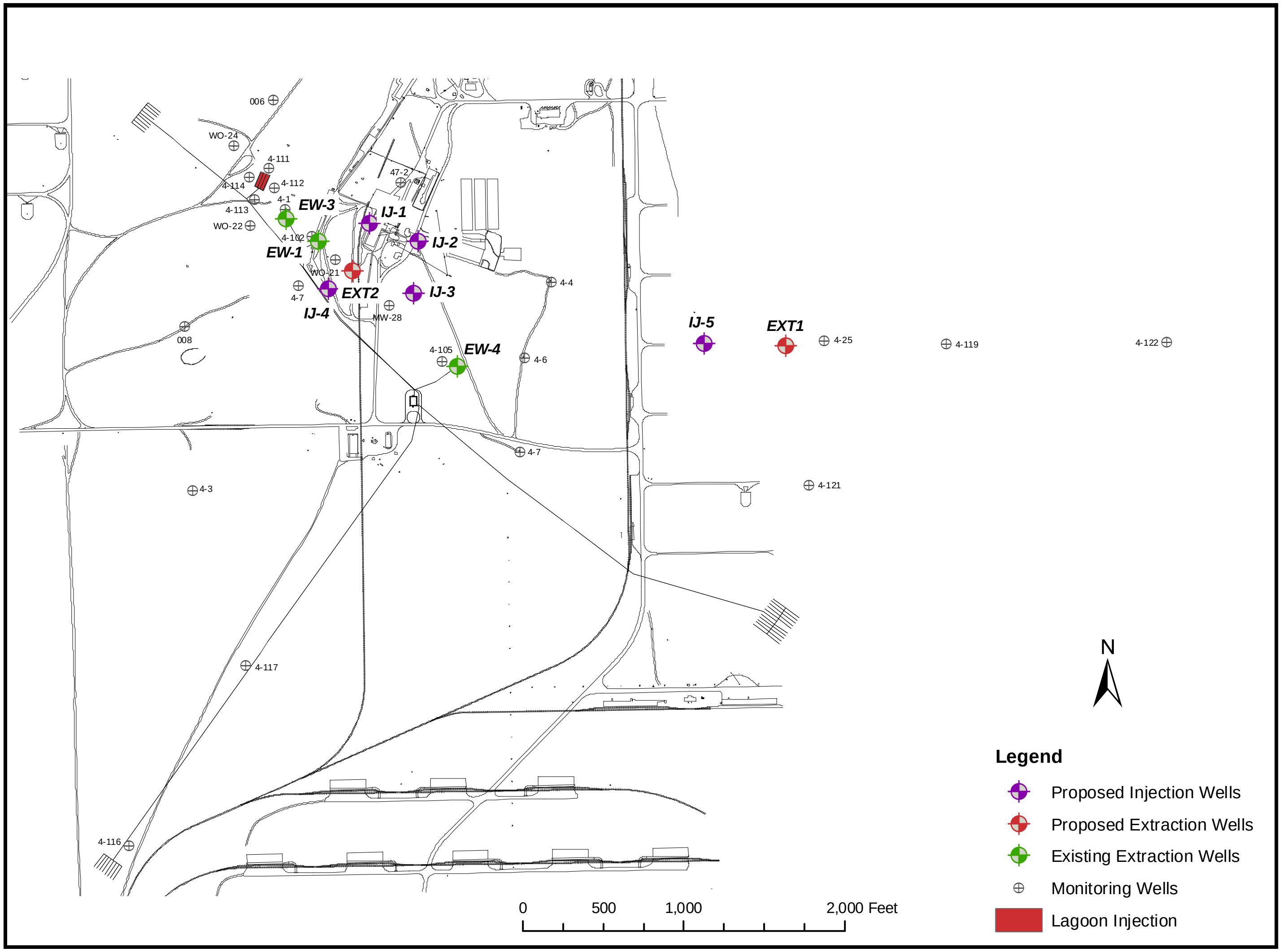
FIGURE 1-11. RDX GROUNDWATER CONCENTRATION MAP, FALL 2008.

Figure 1-3. TNT Plume, Fall 2008



From the following figure in the Draft Final FFS:
FIGURE 1-13. TNT GROUNDWATER CONCENTRATION MAP, FALL 2008.

Figure 1-4. Layout of Alternative 4 (Existing EWs and Infiltration Basins, New EWs, and first set of new IWs)



From the following figure in the Draft Final FFS:

FIGURE 3-4. LOCATIONS OF EXISTING AND PROPOSED EXTRACTION WELLS FOR ALTERNATIVE 4, OPTIONAL BIOREMEDIATION IN THE PLUME.

APPENDIX A

Best Management Practice (BMP) Tables

BMP Category A: Planning

BMP A-1: Develop a culture of GSR within the Project Team and encourage GSR ideas from project staff	**Date: 2/7/12** ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☒ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

There has been informal consideration of GSR-related concepts by the Project Team. An example was the considerable effort the Project Team reported they spent in an effort to find local source for corn syrup which is planned as the amendment for in-situ bio (they could not find a suitable local source). However, the GSR Team believes that increased visibility of GSR awareness and concepts could be achieved in site reports, meetings with stakeholders, etc.

BMP A-2: Incorporate a section on GSR in project meetings, work plans, and reports	**Date: 2/7/12** ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☒ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

A section on GSR was not included in the Draft Final FFS. The GSR Team suggests that future reports would benefit from the addition of a section discussing GSR considerations.

BMP Category A: Planning

<table>
<tr><td colspan="2">BMP A-3: Identify and periodically update a list of key stakeholders and their concerns with respect to GSR considerations</td><td>Date: 2/7/12
☒ Applicable
☒ Evaluated
☒ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☐ Fully ☒ Partially ☐ Not Yet ☐ N/A</td><td colspan="2">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☒ Economic ☒ Social</td><td colspan="2">Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td>Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Notes (including discussion of possible value of implementing the BMP):

Regulators (Oregon Department of Environmental Quality and EPA Region 10) are interested in GSR, but they have not yet been engaged in a discussion on GSR, so their specific concerns and interests regarding GSR are not clearly established. The cost impacts and level of up-front investment for this BMP are difficult to quantify. The GSR Team recommends that the Project Team should document specific concerns of various stakeholders regarding GSR, so that they can be considered and addressed (when feasible) in each phase of the remedial process.</td></tr>
</table>

<table>
<tr><td colspan="2">BMP A-4: Schedule activities for appropriate seasons and/or time of day to reduce delays caused by weather conditions and fuel needed for heating or cooling
Examples:
- Work at night in summer to avoid heat stress
- Perform field activities in summer to take advantage of longer daylight</td><td>Date: 2/7/12
☒ Applicable
☒ Evaluated
☒ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A</td><td colspan="2">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☐ Economic ☒ Social</td><td colspan="2">Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td>Resources Conserved:
☐ Hazardous air pollutants ☒ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☒ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Notes (including discussion of possible value of implementing the BMP):

Construction (likely 1-2 months of work) for new wells and piping is planned for Spring 2012. While this has more to do with the overall project schedule, spring or early summer are generally preferable for outdoor work in this region, since heating would be needed in winter and cooling stations may be needed in summer.</td></tr>
</table>

BMP A-5: Prepare, store, and distribute documents electronically	**Date: 2/7/12** ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☒ Waste ☐ Criteria pollutants ☒ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Reports are distributed electronically unless hard copies are requested. For these hard copy deliverables, long appendices such as lab reports are distributed on disc rather than on paper.

BMP A-6: Utilize teleconferences rather than meetings when feasible	**Date: 2/7/12** ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☐ Waste ☒ Criteria pollutants ☐ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Calls are conducted in place of meetings whenever possible, usually resulting in meetings only once per year (or more as needed), consisting of site update meetings with client, regulators, and USACE, whose offices are in different cities.

BMP A-7: Incorporate green specifications into solicitations and contracts Examples: - Follow pertinent green procurement policies - Select hotel chains with "green" policies - Select laboratories that utilize renewable energy		**Date: 2/7/12** ☒ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A	
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000	
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☒ Land-use	☐ BMP otherwise required? If checked, required by:	

Notes (including discussion of possible value of implementing the BMP):

This has not yet been implemented, but will be considered. Green specifications could be incorporated into construction contracts.

BMP A-8: Integrate schedules to allow for resource sharing and fewer days of field mobilization		**Date: 2/7/12** ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A	
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000	
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☐ Waste ☒ Criteria pollutants ☐ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:	

Notes (including discussion of possible value of implementing the BMP):

It was stated during the Step 5 call that the sampling team for this site, which gets to the site from Seattle District via car, does additional sampling at other places on the site at the same time sampling is performed for this project, which is a form of resource sharing that avoids additional mobilizations (i.e., practical and fully implemented).

Drilling, piping, and electrical work will be done sequentially, so this BMP is not applicable for that aspect of Alternative 4.

BMP Category A: Planning

<table>
<tr><td colspan="2">BMP A-9: Explore multiple site reuse options, including those that include some restriction of site reuse and related resource conservation</td><td>Date: 2/7/12
☐ Applicable
☐ Evaluated
☐ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A</td><td colspan="2">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social</td><td colspan="2">Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="2">Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td>☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Notes (including discussion of possible value of implementing the BMP):

The current plan involves remediating to unrestricted use, and the FFS is not addressing any potential changes to future use.</td></tr>
</table>

<table>
<tr><td colspan="2">BMP A-10: Conduct thorough review of project documents and historical records to minimize required scope of investigation
Examples:
- IRP projects: determine if there are previous aquifer tests that can be used for groundwater modeling rather than conducting new aquifer tests
- MMRP projects: perform careful review of historic documents, aerial photographs, and other existing information to reduce the footprint of land that needs to be disturbed for thorough investigation and remediation
- MMRP projects: use IRP sampling data to supplement and enhance the MMRP field program (if available)</td><td>Date: 2/7/12
☒ Applicable
☒ Evaluated
☒ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A</td><td colspan="2">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
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<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
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☒ GHG emissions (CO2e) ☒ Water ☐ Land-use</td><td>☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Notes (including discussion of possible value of implementing the BMP):

Previous studies and historical O&M data have been reviewed to develop and evaluate the alternatives in the FFS.</td></tr>
</table>

BMP Category B: Characterization and/or Remedy Approach

BMP B-1: Develop and routinely update a conceptual site model (CSM) to use as a basis for making remedial process decisions		**Date: 2/7/12** ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A	
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000	
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:	
Notes (including discussion of possible value of implementing the BMP): *The FFS contains a section which describes the CSM, which has been updated based on previous O&M data and pilot studies. The cost impacts and level of up-front investment for this BMP are difficult to quantify.*		

BMP B-2: Perform frequent optimization evaluations to improve efficiency of current or planned actions and/or develop alternative remedial approaches that might shorten remedy duration or otherwise improve the net environmental benefit of the remedy		**Date: 2/7/12** ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A	
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000	
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☐ Safety/Community ☒ GHG emissions (CO2e) ☒ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:	
Notes (including discussion of possible value of implementing the BMP): *A series of optimization evaluations have been conducted. An excellent example of specific optimization was a recent evaluation of pulse pumping, and the FFS represents a big-picture approach to optimization of the remedy. Other historical optimization efforts included flushing the source area in the initial stage of P&T, performing an Independent Design Review (2006), optimizing the well monitoring program, optimizing the process of sampling for GAC changeout, and pumpage optimization as part of a previous ESTCP project that led to discontinued recharge at one of the infiltration galleries. The up-front costs of these optimization efforts are difficult to quantify, but it is expected that they cause net cost savings.*		

BMP Category B: Characterization and/or Remedy Approach

<table>
<tr><td colspan="2">BMP B-3: Use appropriate characterization or remedy approach based on site conditions
Examples:
- Consider in-situ and passive remedy options that offer adequate protectiveness
- Consider in-situ bioremediation if conditions are already anaerobic and constituents are conducive to reductive dechlorination
- Compare source removal versus in-situ and ex-situ remedial options
- Consider different technologies for impacted areas with higher and lower concentrations
- Use realistic times to remedy closeout (i.e., estimations through modeling) rather than assumed remedy timeframes (e.g., 30 years), which is often used for evaluation of FS alternatives
- MMRP projects: evaluate man-portable DGM instruments versus vehicle-towed array (VTA) instruments and inclusion of detector-aided reconnaissance (DAR)</td><td>Date: 2/7/12
☒ Applicable
☒ Evaluated
☒ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A</td><td colspan="2">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
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<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
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☒ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Notes (including discussion of possible value of implementing the BMP):

Air rotary drilling will be used for well installation since this will be the quickest and most economical method. Since geology is well established, split spoons will not be performed over the majority of the well depth to speed the drilling (split spoons may be collected within the screened interval). Treatability studies (push-pull tests) were conducted for various bioamendments. Corn syrup was selected by the Project Team based on their interpretation of results of these tests. The Project Team reported that, while corn syrup was not the longest lasting of the materials tested, it was the best for degradation (and also reported that the longer lasting substrates did not provide adequate RDX degradation).</td></tr>
</table>

<table>
<tr><td colspan="2">BMP B-4: Establish decision points to trigger a change from one technology to another or from one remedy alternative to another
Examples:
- Change vapor treatment from thermal oxidation to granular activated carbon (GAC) media based on flow rates and concentrations
- Remove a treatment polishing step if influent to that step already meets discharge criteria
- Move to Monitored Natural Attenuation (MNA) if specific concentration thresholds in groundwater are met</td><td>Date: 2/7/12
☒ Applicable
☒ Evaluated
☒ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A</td><td colspan="2">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
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<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
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If checked, required by:</td></tr>
<tr><td colspan="3">Notes (including discussion of possible value of implementing the BMP):
The decision to change the current pump and treat system to an alternative remedy was made based on decreased effectiveness of the current system in removing contaminant mass and reducing contaminant concentrations. For the selected alternative, sampling will be conducted to determine when to transition from pump and treat to bioremediation.</td></tr>
</table>

BMP Category B: Characterization and/or Remedy Approach

<table>
<tr><td colspan="3">BMP B-5: Focus sampling efforts to meet objectives of the specific remedial phase (e.g., sampling during O&M should be focused on evaluating remedy performance and not on thorough plume characterization)
Examples:
- Eliminate sampling parameters as appropriate
- Reduce sampling frequency as appropriate
- Reduce sample locations as appropriate
- Enhance monitoring program as appropriate
- MMRP projects: consider Incremental Sampling Methodology (ISM) versus discrete sampling for MC characterization</td><td>Date: 2/7/12

☒ Applicable
☒ Evaluated
☒ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
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<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
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<tr><td colspan="2">Resources Conserved:
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☒ Criteria pollutants ☒ Materials ☒ Safety/Community
☒ GHG emissions (CO2e) ☒ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

The Project Team reported during the Step 5 call that LTM optimization has been performed in the past, and that during the O&M period the compliance monitoring (i.e., LTM of groundwater) has gone down to 26 wells as a result of significant reductions over time. With respect to process monitoring in the treatment plant (i.e., for carbon), the system has been sampled monthly when operating (though it has not been operating since February 2009 while pulsed pumping was tested and system changes were being evaluated).</td></tr>
</table>

BMP Category B: Characterization and/or Remedy Approach

BMP B-6: Consider real-time measurements and dynamic work plans to reduce mobilizations and improve effectiveness of investigation efforts Examples: - Field test kits (e.g., test kits for sulfate) - Field screening instruments (e.g., x-ray fluorescence for lead or photoionization detectors for volatile organics) - Drive point sensor technologies (e.g., membrane interface probe or "MIP") - Visual staining or odor - Establish excavation extent based on real-time data collected as excavation proceeds and use GPS to accurately delineate excavation areas - MMRP projects: use GPS and/or the same equipment that was used for detection to confirm anomaly signatures prior to excavating - MMRP projects: consider incorporating field screening methods (e.g., X-ray fluorescence, EXPRAY and explosives test kits, as appropriate or applicable) into the field program to refine sampling locations and reduce the quantities of samples submitted for off-site laboratory analysis	**Date: 2/7/12** ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Field kits to test for ferrous iron (i.e., hach kits) are being used for lagoon treatability tests.

Carol Dona reported that, when the system was operating, GAC testing at mid-GAC point used a 24-hour turnaround time that served as a type of "real time measurement" for making carbon change decisions (the GSR Team did not review or evaluate this carbon change strategy).

BMP Category B: Characterization and/or Remedy Approach

BMP B-7: Consider use of existing site structures/infrastructure or mobilization of temporary structures versus new construction Examples: - Buildings (e.g., for treatment building or field office) - Concrete slabs or foundations - Wells - Existing excavations for storm water control	**Date: 2/7/12** ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☐ Water ☒ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *All of the proposed alternatives in the FFS utilize existing infrastructure (wells, treatment building, and infiltration fields). Alternative 4 (regarded as the preferred alternative in the FFS) utilizes the historical washout lagoon for infiltration of amended water in the original source area.*	

BMP B-8: Establish project-specific decision points to limit extent of remediation Examples: - Project-specific cleanup levels based on a site-specific risk assessment (coordinated with risk assessment experts) rather than generic cleanup levels, if it results in lower footprints for key parameters and is acceptable to all stakeholders - MMRP projects: dig stopping rules and anomaly prioritization/detection criteria to minimize false positives	**Date: 2/7/12** ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☒ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☐ Safety/Community ☒ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *While the cleanup goal for RDX is 2 ppb, the FFS assumes it is not practical to target the entire 2 ppb plume for active remediation such is in-situ bio, and therefore the in-situ bio is targeting the 20 ppb plume for active remediation (which would hopefully lead to ultimately meeting the cleanup goal throughout most or all of the aquifer over time via other technologies that might include passive approaches).*	

BMP Category B: Characterization and/or Remedy Approach

<table>
<tr><td colspan="3">BMP B-9: Consider leaving in place structures whose removal is not necessary (i.e., foundations, underground pillars, etc.)</td><td>Date: 2/7/12
☐ Applicable
☐ Evaluated
☐ Practical</td></tr>
<tr><td>Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
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If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

This BMP is not applicable for this project – no structures are planned to be removed.</td></tr>
</table>

BMP Category C: Energy/Emissions – Transportation

BMP C-1: Reduce the number of trips for personnel Examples: - Encourage carpooling - Use telemetry systems and webcams to remotely transmit data directly to project offices to avoid trips	**Date: 2/7/12** ☒ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *It was discussed during the Step 5 call that currently there is a local person doing O&M (within ~20 miles of site), with switch to in-situ bio in Alternative 4 (after ~5 years) there would be fewer trips (i.e., just for injections, which would occur at most 3 times per year) but during those month-long injection periods there would be more trips and more people. For the current situation, carpooling is not an option (just one person). The potential for carpooling in the future injection events for in-situ bio was not fully evaluated by the GSR Team.*	

BMP C-2: Reduce the number of trips and/or volume for transported materials, equipment, or waste Examples: - Transfer full loads by consolidating shipments from vendors and/or shipments to disposal sites (also share shipments with neighbors if feasible) - Purchase more concentrated chemicals to reduce transportation weight and/or volume	**Date: 2/7/12** ☒ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Used GAC is sent to Red Bluff, CA for regeneration when the P&T system is operating. Since the system has been inactive, the GAC has not been changed since 2009. This represents the main material, and it is not clear if this can be reduced other than by ultimately eliminating P&T, which is a goal of Alternative 4 (i.e., P&T for limited time, followed by in-situ bio).* *For the in-situ bio, the primary material is the corn syrup. It is assumed that deliveries will be coordinated to minimize trips, but that was not fully evaluated by the GSR Team.*	

BMP Category C: Energy/Emissions – Transportation

BMP C-3: Reduce trip lengths Examples: - Dispose of waste at closest appropriate facility - Purchase materials, equipment, and services from local vendors - Use locally produced supplies - Select most efficient transportation route	**Date: 2/7/12** ☒ Applicable ☒ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☐ Waste ☒ Criteria pollutants ☐ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):
Under the existing contract, the system operator is locally based (approximately 20 miles from the site). For semi-annual monitoring events, field personnel travel from Seattle. Drilling and piping will likely come from Tacoma or Spokane. It is not clear that these trip lengths can be reduced.

An attempt was made to find a local source for corn syrup, but the closest practical source that could provide the required quantities is located in Tennessee. Thus, shortening the trip length does not appear to be practical unless another substrate is utilized, but the Project Team has indicated that based on the push-pull tests they want to use the corn syrup.

The ERCD lab in MS has been used for pilot testing; but other accredited labs are used for compliance sampling. The Project Team indicates that the current contract for (semi-annual) compliance sampling is with a Wisconsin-based lab. It seems likely that a lab could be used in Seattle via air or ground transport. The GSR Team recommends that the Project Team evaluate the practicality of using a closer lab such as in Seattle, and evaluate the practicality of air and ground transport for such a lab.

BMP C-4: Use alternate fuels or other options for transportation when possible Examples: - Compressed natural gas - Biodiesel blends - Ethanol blends - Hybrid and/or electric - Rail lines versus trucks - Use a fuel efficient passenger car rather than a pickup truck if task allows	**Date: 2/7/12** ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☐ Waste ☒ Criteria pollutants ☐ Materials ☐ Safety/Community ☒ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Corn syrup is transported via rail from Tennessee to Seattle, and via truck from Seattle to Umatilla. Using the rail lines is considered an "alternate transportation option"

BMP Category D: Energy/Emissions – Equipment Use

<table>
<tr><td colspan="2">BMP D-1: Consider and implement approaches to minimize engine idle times</td><td>Date: 2/7/12
☒ Applicable
☒ Evaluated
☒ Practical</td></tr>
<tr><td>Implemented?
("N/A" if "Practical" not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A</td><td colspan="2">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
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☒ Criteria pollutants ☐ Materials ☐ Safety/Community
☒ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Notes (including discussion of possible value of implementing the BMP):

During well drilling, split spoon samples will only be taken in the screen interval, which will reduce drilling idle time.</td></tr>
</table>

<table>
<tr><td colspan="2">BMP D-2: Ensure peak operating efficiency of equipment to reduce energy use and emissions
Examples:
- Perform preventative maintenance and operate equipment per manufacturer instructions
- Perform retrofits involving low-maintenance multi-stage filters for cleaner engine exhaust
- Use synthetic oil to extend operating life (and reduce waste oil)
- Purchase newer equipment with reduced emissions</td><td>Date: 2/7/12
☒ Applicable
☒ Evaluated
☒ Practical</td></tr>
<tr><td>Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☒ Not Yet ☐ N/A</td><td colspan="2">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☒ Economic ☐ Social</td><td colspan="2">Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td>Resources Conserved:
☒ Hazardous air pollutants ☒ Energy ☐ Waste
☒ Criteria pollutants ☐ Materials ☐ Safety/Community
☒ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Notes (including discussion of possible value of implementing the BMP):

This BMP should be implemented by the contractor for drilling and pipe laying. It has not yet been implemented since the construction phase is in the future.</td></tr>
</table>

BMP Category D: Energy/Emissions – Equipment Use

BMP D-3: Use alternate fuel options for equipment when possible Examples: - Compressed natural gas - Biodiesel - Ethanol blends - Ultra-low sulfur diesel, wherever available (and as required by engines with PM traps)	**Date: 2/7/12** ☒ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☐ Energy ☐ Waste ☒ Criteria pollutants ☐ Materials ☐ Safety/Community ☒ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *It is too early in the process for this BMP to be applied, but it should be considered construction.*	

BMP D-4: Select appropriate equipment and/or power source for the job Examples: - Avoid using large excavators for small earthmoving projects - Use direct push methods when possible to reduce drilling duration - Compare potential use of electricity versus battery versus generator	**Date: 2/7/12** ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☐ Waste ☒ Criteria pollutants ☐ Materials ☐ Safety/Community ☒ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Air rotary drilling will be used for well installation, which is an appropriate drilling method given site conditions.*	

BMP Category D: Energy/Emissions – Equipment Use

BMP D-5: Use variable frequency drives on motors (e.g., pumps, blowers), or replace oversized motors with properly sized motors	**Date: 2/7/12** ☒ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☒ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☐ Waste ☒ Criteria pollutants ☐ Materials ☐ Safety/Community ☒ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Extraction well pumps are not currently equipped with VFDs. Since the P&T system under Alternative 4 is only expected to operate for up to 5 years (and perhaps less), the benefits and payback period would need to be considered. This will depend on how much the pump motors are currently throttled back. This has not been fully evaluated because the FFS does not provide details regarding the specific pump motors and throttle positions that would be required to quantify this, but the GSR Team recommends the Project Team evaluate and document the potential use of VFDs on a motor-by-motor basis during system design.

BMP D-6: Identify options for generating renewable energy for direct use in the remedy and/or for alternate use at or near the project site Examples: - Solar, wind, landfill gas (microturbines), combined heat and power, geothermal heat exchange - Applications for remote areas such as solar pumps or solar flares (if demand is not continuous, the need for a battery backup may be avoided) - Generate power or heat exchange from water to be discharged	**Date: 2/7/12** ☒ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☐ Waste ☒ Criteria pollutants ☐ Materials ☐ Safety/Community ☒ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

The tanks for corn syrup require heating (the tank currently on site used for corn syrup injection pilot testing is painted black to absorb and retain heat). The Project Team is considering using solar power (presumably solar thermal) to heat the holding tanks for corn syrup rather than dropping a power line and the GSR Team recommends this be fully evaluated during the design phase (i.e., not yet evaluated).

Extracted water could potentially provide heating and cooling via a heat pump. However, the Project Team indicated there is no obvious potential user for the heating and cooling nearby (i.e., not practical).

BMP Category D: Energy/Emissions – Equipment Use

BMP D-7: Consider purchase of renewable energy certificates to offset emissions from the remedial activities	**Date: 2/7/12** ☒ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☒ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Purchase of RECs may not be practical for this site since much of the electricity for this part of the country is already produced from renewable sources.

BMP D-8: Design/modify housing required for above-ground treatment components for energy-efficiency Examples: - Passive lighting - Compact fluorescent lighting (CFL) or light-emitting diode (LED) lighting - Timers and/or motion control sensors for lighting - Shading - Minimize heating and cooling needs (building size, insulation, etc.)	**Date: 2/7/12** ☒ Applicable ☒ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☒ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☒ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☐ Waste ☒ Criteria pollutants ☐ Materials ☐ Safety/Community ☒ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

The treatment system began operation in 1996, and while the building is insulated, no known modifications for energy efficiency have been performed to date. Such modifications may not be practical at this point with the anticipated shutdown of the pump and treat system in approximately 5 years or less.

BMP Category D: Energy/Emissions – Equipment Use

BMP D-9: For remedies that involve groundwater or air extraction, optimize extraction to reduce flow rates (potentially beneficial with respect to energy use, materials usage, water resources, waste disposal, etc.)	**Date: 2/7/12** ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☐ Waste ☒ Criteria pollutants ☐ Materials ☐ Safety/Community ☒ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Modeling has been done to optimize pumping rates in the past, and the site participated in an ESTCP project to optimize pumping/recharge approximately 10 years ago, which led to eliminating recharge at one of the recharge galleries. In addition, the process of evaluating alternatives in the FFS that will eliminate P&T in the future is a broad form of pumpage optimization.*	

BMP D-10: Consider pulsing for extraction of water or air to maximize mass removal per unit of time or energy, by extracting higher concentrations	**Date: 2/7/12** ☒ Applicable ☒ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *A pulse pumping optimization evaluation was conducted, and it was determined that pulsing resulted in lower total mass removal than continuous operation.*	

BMP Category D: Energy/Emissions – Equipment Use

<table>
<tr><td colspan="2">BMP D-11: Run electrical equipment during times of lower electric demand if possible (this does not reduce energy use but could lower cost and also can lower stress on the energy grid during periods of peak demand)</td><td>Date: 2/7/12
☐ Applicable
☐ Evaluated
☐ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A</td><td colspan="2">Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social</td><td colspan="2">Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td>Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Notes (including discussion of possible value of implementing the BMP):

This BMP is not applicable for this project.</td></tr>
</table>

BMP Category E: Materials & Off-Site Services

BMP E-1: Use materials that are made from recycled materials Examples: - Steel - Asphalt - Plastics - Concrete	**Date: 2/7/12** ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☐ Safety/Community ☒ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Regenerated GAC is used for groundwater treatment (i.e., practical and implemented).

Off-spec corn syrup was considered, but the Project Team identified issues with pH of the substrate in addition to being unable to obtain the necessary quantities of corn syrup (i.e., not practical). As the project progresses, the source and quality of corn syrup can potentially be optimized.

BMP E-2: Optimize the amount of materials used Examples: - Experiment with different material amounts/doses - Consider alternate materials - Use timers or feedback loops and process controls for dosing - MMRP projects: minimize quantities of donor explosives for MEC destruction	**Date: 2/7/12** ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☒ Waste ☒ Criteria pollutants ☒ Materials ☐ Safety/Community ☒ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

Carol Dona reported that, when the system was operating, GAC testing at mid-GAC point used a 24-hour turnaround time that served as a type of "real time measurement" for making carbon change decisions (the GSR Team did not review or evaluate this carbon change strategy). Presumably this was to reduce the frequency of changeouts.

Alternative 4 in the FFS incorporates steps to optimize quantity of corn syrup over time (e.g., reduced injection frequency over time).

BMP Category E: Materials & Off-Site Services

BMP E-3: Utilize less refined materials when feasible Examples: - Limestone instead of sodium hydroxide for pH adjustment - Native fill instead of select fill		**Date: 2/7/12** ☒ Applicable ☒ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A	
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000	
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☒ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:	
Notes (including discussion of possible value of implementing the BMP): *Off-spec corn syrup was considered, but was not selected for the reasons stated above (see BMP E-1).*		

BMP E-4: Identify opportunities for using by-products or "waste" materials from local sources in place of refined chemicals or materials Examples: - Cheese whey, molasses, compost, or off-spec food products for inducing anaerobic conditions - Crushed concrete for use as fill - Concrete from coal combustion byproducts		**Date: 2/7/12** ☒ Applicable ☒ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A	
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000	
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☒ Waste ☐ Criteria pollutants ☒ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:	
Notes (including discussion of possible value of implementing the BMP): *Off-spec corn syrup was considered, but was not selected for the reasons stated above (see BMP E-1).*		

BMP E-5: Reduce demand on Publicly Owned Treatment Works (POTWs) Examples: - Discharge treated water to groundwater or to surface water rather than POTW - Minimize amount of water requiring treatment	**Date: 2/7/12** ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

This BMP is not applicable for this project; all extracted water is already recharged.

BMP Category F: Water Resource Use

BMP F-1: Minimize water consumption Examples: - Sensors to turn off water when not needed - Low flow fittings - Minimize water needs for irrigation (landscape choices, use of mats and mulch)	**Date: 2/7/12** ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP is not applicable for this project. Water is not being consumed by remedial activities at the site, since all water is re-injected (and extracted water will be used for bio injections).*	

BMP F-2: Preferentially use less refined water resources when feasible Examples: - Use extracted groundwater instead of potable water for chemical blending - Capture and store rain/storm water for future use - Employ rumble grates with a closed-loop gray-water washing system	**Date: 2/7/12** ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☒ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Extracted water is being used for mixing with bio amendments instead of potable water.*	

BMP Category F: Water Resource Use

BMP F-3: Use extracted and treated water for beneficial purposes Examples: - Irrigation - Potable water - Industrial process water	**Date: 2/7/12** ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☒ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *For this project, recharge of treated water during P&T is serving a beneficial purpose by keeping up the water table which is already low due to use of water for irrigation (i.e., practical and fully applied).* *During the Step 5 call it was discussed that there would be some potential for using extracted water for heating and cooling using heat exchange before it is recharged, except the Project Team reported that there is no major demand for heating and cooling nearby (i.e., this is not currently practical).*	

BMP F-4: Promote groundwater recharge Examples: - Recharge extracted and treated water when beneficial uses of the water are not identified and reinjection is practical - Minimize site area covered by impervious surfaces to reduce runoff and maximize infiltration (unless such capping is a specific component of the remedial action)	**Date: 2/7/12** ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☒ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Treated water is being re-injected, which promotes groundwater recharge.*	

BMP Category F: Water Resource Use

BMP F-5: Maintain water quality by preventing nutrient loading to surface water or groundwater Examples: - Use phosphate-free detergents instead of organic solvents or acids to decontaminate sampling equipment (if not required for some contaminants)	**Date: 2/7/12** ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

This BMP is not applicable for this project.

BMP Category G: Waste Generation, Disposal, and Recycling

BMP G-1: Minimize drill cuttings and all other investigation derived waste (including personal protection equipment) Examples: - Direct push or sonic drilling to reduce drill cuttings - Low-flow sampling or passive diffusion bags (if applicable) to reduce purge water - When possible place drill cuttings on-site rather than off-site disposal	**Date: 2/7/12** ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☒ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *The depth to water at this site is too great to use direct push for well installation. Drill cuttings have been spread on the surface in the past outside of higher concentration areas, but in some cases cuttings may need to be containerized.* *Low-flow sampling with dedicated bladder pumps is used (reduces purge water), and purge water currently goes through the treatment system and is then recharged to the aquifer.*	

BMP G-2: Segregate excavated soil in pre-planned staging areas so that "clean" material can be deposited on-site and/or reused rather than transported for off-site disposal	**Date: 2/7/12** ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP is not applicable for this site.*	

BMP G-3: Consider on-site treatment and re-use of soil instead of off-site disposal
Examples:

- Land farming
- Above ground soil vapor extraction (SVE)

Date: 2/7/12
☐ Applicable
☐ Evaluated
☐ Practical

Implemented?
("N/A" if "Practical" not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

This BMP is not applicable for this site.

BMP G-4: Minimize need to transport and dispose hazardous waste
Examples:

- Consider delisting listed hazardous waste if waste is not characteristically hazardous waste
- Segregate hazardous waste and non-hazardous waste

Date: 2/7/12
☒ Applicable
☒ Evaluated
☒ Practical

Implemented?
("N/A" if "Practical" not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☒ Environmental ☒ Economic ☒ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000

Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☒ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use

☐ BMP otherwise required?
If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

The GAC loading limits take into account the explosives limits to avoid the spent GAC being hazardous.

BMP Category G: Waste Generation, Disposal, and Recycling

BMP G-5: When possible avoid/minimize use of hazardous/toxic materials that may require special handling or disposal Examples: - Cleaning solutions - Pesticides - Disposable batteries (use rechargeable batteries) - MMRP projects: minimize Chemical Agent Contaminated Media (CACM) at RCWM sites.	**Date: 2/7/12** ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP is not applicable for this site.*	

BMP G-6: Recycle or reuse materials rather than disposing of them Examples: - Cardboard - Plastics - Concrete - Asphalt - Steel and other metals - Recovered oil/product - Mulch/compost - MMRP projects - recycle recovered Material Documented as Safe (MDAS) after inspection and certification that the remnants are free of explosive hazards	**Date: 2/7/12** ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☒ Waste ☐ Criteria pollutants ☒ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Little waste is generated by the current treatment system, but spent GAC is regenerated.*	

BMP Category H: Land Use, Ecosystems, and Cultural Resources

BMP H-1: Minimize erosion and soil transport to surface water bodies Examples: - Quickly restore any vegetated areas disrupted by equipment or vehicles - Institute appropriate erosion controls during excavation such as silt fencing	**Date: 2/7/12** ☒ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☒ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP has not yet been evaluated, but will likely be applied during construction (for excavation related to piping).*	

BMP H-2: Minimize disturbances to land Examples: - Establish well-defined traffic patterns for onsite activities to minimize disturbed areas - Consider non-intrusive investigation techniques (e.g., geophysical methods) to identify items like USTs and buried drums	**Date: 2/7/12** ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☒ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Some trenching will occur, but excavated soil will be replaced and no damage to infrastructure (i.e. roads and treatment building) is anticipated.*	

BMP Category H: Land Use, Ecosystems, and Cultural Resources

BMP H-3: Preserve/restore ecosystems to the extent possible Examples: - Limit the removal of trees and vegetation - Attempt to transplant disturbed shrubs and small trees to other locations - Use native species for re-vegetation - Retrieve dead trees during excavation and later reposition them as habitat snags - Select and place suitably sized and typed stones into water beds and banks - Undercut surface water banks in ways that mirror natural conditions - Cut back rather than remove trees, bushes, vegetation	**Date: 2/7/12** ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP is not applicable for this project. There are no natural surface water expressions in the vicinity of the site, and the very dry, permeable soil at the site does not support extensive ecosystems.*	

BMP H-4: Minimize drawdown of the water table in sensitive areas such as wetlands or areas subject to subsidence	**Date: 2/7/12** ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP is not applicable for this project (see above).*	

BMP H-5: Construct wells and other remedial process infrastructure (piping, buildings, etc.) to minimize restrictions to anticipated future use of the site	**Date: 2/7/12** ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☒ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *Remedial activity is not expected to limit future land use beyond those limits already imposed.*	

BMP H-6: Preserve/restore cultural resources to the extent possible Examples: - Protected lands such as wildlife refuges, national parks, and wilderness areas - Culturally sensitive sites such as cemeteries, native burials, and archaeological finds - Buildings or land parcels with historical significance	**Date: 2/7/12** ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP is not applicable for this project.*	

<table>
<tr><td colspan="3">BMP H-7: Document sensitive ecological and cultural resources prior to initiating actions that might diminish or destroy those resources
Examples:
- Photodocument conditions prior to clearing brush
- MMRP projects: photodocument conditions prior to BIP</td><td>Date: 2/7/12
☐ Applicable
☐ Evaluated
☐ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☐ Fully ☐ Partially ☐ Not Yet ☒ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☐ Social</td><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="2">Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☐ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

This BMP is not applicable for this project.</td></tr>
</table>

BMP Category I: Safety and Community

BMP I-1: Minimize and mitigate noise, light and odor disturbance during all phases of the remedial process, to the extent practicable	**Date: 2/7/12** ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP is not applicable for this project, since the site is in a fairly remote area.*	

BMP I-2: Minimize dust during construction activities by spraying water or techniques such as laying biodegradable mats, tarps, or materials (already in EM385-1-1)	**Date: 2/7/12** ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *The Project Team indicated that no dust suppression is expected to be needed at this site.*	

BMP I-3: Select transportation routes for trucks and heavy equipment that minimize impacts to residential areas to maximize safety and minimize noise and other aesthetic impacts	**Date: 2/7/12** ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☒ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

The site is accessible from major highways, so trips through residential areas should not be necessary.

BMP I-4: Minimize drawdown of the water table in areas that could impact production rates at supply wells and/or irrigation wells	**Date: 2/7/12** ☒ Applicable ☒ Evaluated ☒ Practical
Implemented? ("N/A" if "Practical" not checked) ☒ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☐ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☒ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:

Notes (including discussion of possible value of implementing the BMP):

All extracted water is re-injected. In addition, the Project Team is trying to move away from a pump and treat system.

BMP I-5: Minimize amount of time that heavy machinery is needed to enhance safety	**Date: 2/7/12** ☒ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☒ Environmental ☒ Economic ☒ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☒ Hazardous air pollutants ☒ Energy ☐ Waste ☒ Criteria pollutants ☐ Materials ☒ Safety/Community ☒ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *It is expected that this BMP will be implemented during construction activities.*	

BMP I-6: Minimize handling of dangerous chemicals by selecting alternate chemicals and/or engineering to minimize contact with chemicals (for MMRP projects, there is enhanced risk related to explosion potential and exposure to chemical agents (CA) and agent breakdown products (ABP) associated with RCWM responses)	**Date: 2/7/12** ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☒ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use	☐ BMP otherwise required? If checked, required by:
Notes (including discussion of possible value of implementing the BMP): *This BMP is not applicable for this project.*	

BMP Category I: Safety and Community

<table>
<tr><td colspan="3">BMP I-7: Contribute to local economy when possible
Examples:
- Consider leasing local office space
- Purchase or lease equipment from local vendors
- Hire workers from local community</td><td>Date: 2/7/12
☒ Applicable
☒ Evaluated
☒ Practical</td></tr>
<tr><td>Implemented?
(“N/A” if “Practical” not checked)
☒ Fully ☐ Partially ☐ Not Yet ☐ N/A</td><td colspan="3">Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):
☐ Cost Increase ☒ Cost Savings ☐ Cost Neutral ☐ N/A</td></tr>
<tr><td>GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):
☐ Environmental ☐ Economic ☒ Social</td><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
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<tr><td colspan="2">Resources Conserved:
☐ Hazardous air pollutants ☐ Energy ☐ Waste
☐ Criteria pollutants ☐ Materials ☒ Safety/Community
☐ GHG emissions (CO2e) ☐ Water ☐ Land-use</td><td colspan="2">☐ BMP otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="4">Notes (including discussion of possible value of implementing the BMP):

The system operator lives locally. The in-house sampling team travels to the site from Seattle by car.</td></tr>
</table>

BMP Category J: Other Site-Specific BMPs

BMP J-1:			**Date: 2/7/12** ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A		
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000		
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use		☐ BMP otherwise required? If checked, required by:	
Notes (including discussion of possible value of implementing the BMP):			

BMP J-2:			**Date: 2/7/12** ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A		
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000		
Resources Conserved: ☐ Hazardous air pollutants ☐ Energy ☐ Waste ☐ Criteria pollutants ☐ Materials ☐ Safety/Community ☐ GHG emissions (CO2e) ☐ Water ☐ Land-use		☐ BMP otherwise required? If checked, required by:	
Notes (including discussion of possible value of implementing the BMP):			

Appendix B

Assumptions for SiteWise Input and Other Calculations, Umatilla OU3:

Alternative 4 (Baseline)

Appendix B
Assumptions for SiteWise Input and Other Calculations
Umatilla Chemical Depot Pilot GSR Evaluation:

Pump & Treat System Expansion and Bioremediation (Alternative 4, Baseline)

SiteWise "RA_Baseline_NoFR_1" Directory

According to the Draft Final FFS (dated 26 August, 2011), the planned alternative at this site (referred to as Alternative 4) includes an enhanced version of the current pump and treat system coupled with bioremediation, with an option to transition in the future to full-scale bioremediation only. For the purposes of costing and footprinting, this alternative is assumed to involve the following components:

- Installation of 2 new extraction wells at the beginning of the 15-year period
- Two injection well tests for in-situ bio (each including installation of a new injection well)
- Continuous P&T with GAC treatment for 5 years using 2 extraction wells, with an additional 3 extraction wells operated periodically
- Injecting corn syrup (8,150 gallons per event) through the existing infiltration gallery at the waste lagoon (the original source area) for 7 days, 3 times per year for 5 years
- 2 extraction wells near the waste lagoon (EW-1 and EW-3) will operate during the 7-day injection period during the first 5 years (this is the water that will be used for the injections)
- The transition to full-scale bioremediation is assumed to occur after 5 years (this transition could potentially occur sooner)
- 4 new injection wells will be installed for the initial 2 yr bio period after the first five year period is completed; these wells will be utilized as needed during the entire 10 year full-scale bio period
- An estimated 4 additional injection wells may subsequently be installed for the following 8 yr bio period to better target areas of high contamination, and are assumed for the GSR evaluation
- 1 existing extraction well will be used as an injection well, and 3 existing extraction wells will be used to encourage distribution of injected substrate during this 10 year period of full-scale bio
- 3 treatment events per year for the first 2 years of full-scale bio, using 262,700 gallons of corn syrup per event. Events will last 30 days, with the system at rest for the following 3 months
- It is assumed that injections will continue at 25% of the original substrate mass 2 times per year for the following 4 years then 1 time per year for an additional 4 years
- O&M and monitoring were costed for a total of 15 years; actual duration of remedial action, O&M and monitoring would be subject to performance evaluation based on measured site data

Unless otherwise noted, SiteWise inputs are based on the RACER output information described in the Section C.5 Assembly Level Data Report for Alternative 4, found in Appendix C of the Draft Final FFS. In some cases that information was superseded or clarified by the Project Team via email.

The notes pertaining to SiteWise input are organized by the following tabs of the SiteWise input sheet:

- P&T System O&M (First 5 years)– *Uses "Remedial Investigation" tab of the SiteWise input sheet* (includes labor for the limited bio injections at waste lagoon during that period because it is linked with the system O&M, but the materials such as corn syrup for the bio are included in the "Remedial Action Operations" tab of the SiteWise input sheet)

Baseline – Overview

- Remedy Construction and Well Installation – *Uses "Remedial Action Construction" tab of SiteWise input sheet*
- Bioremediation (Including Studies and Testing) – *Uses "Remedial Action Operations" tab of SiteWise input sheet* (does not include operator labor for the limited bio in the first 5 years, which is included in the "Remedial Investigation" tab of the SiteWise input sheet
- Monitoring and 5-Year Reviews – *Uses "Longterm Monitoring" tab of SiteWise input sheet*

For each section of SiteWise, all the sections are listed, with pertinent information added only for those sections of the input sheet where data were added.

It should be noted that electricity use entered into SiteWise is based on various items in the RACER Assembly Level Data Report (i.e., Appendix C of the Draft Final FFS) described as "Electrical Charge", each of which lists a number of kWh used.

In some cases, small quantities of materials (such as copper wire, PVC well plugs, bentonite seal on wells, etc.) were not included in SiteWise input because the footprint of these items relative to the other materials used would be expected to be extremely minimal.

Other calculations done outside of SiteWise are then presented. These include the following:

- % of total energy from renewable resources
- Hazardous air pollutants
- Refined material use
- Unrefined material use
- Tons of non-hazardous waste
- Tons of hazardous waste
- % of Potential Waste Recycled
- Risks to on-site workers and from transportation
- Heavy truck trips through residential areas

Additional tables are attached which show how SiteWise outputs were split into "direct" and "indirect" energy use and greenhouse gas emissions. For definitions of direct and indirect energy use and emissions, please refer to section 2.2.2 of the evaluation report.

For cost calculation, costs identified as capital (no discounting) and annual (no discounting) are based on spreadsheet 'Cost Summary_Alt 4_7-31-11.xlsx' provided by Project Team which summarize the RACER results. A summary cost sheet developed by the GSR Team for the 15-year period (which occurs across portions of 16 fiscal years), based on the RACER data, is attached to this Appendix. The Project Team reported in an email that a 7 percent discount rate was utilized to calculate NPV for the Draft Final FFS. Information regarding the cost calculations is as follows:

- The capital costs for Alternative 4 are approximately $13.3M, and are incurred at several different periods to account for different episodes of well drilling, piping, etc. and also include bioremediation substrate and transport/injection of that substrate

Baseline – Overview

- The annual operating costs vary from year to year but are generally on the order of $250,000 to $680,000 per year

- The sum of capital and annual costs, non-discounted, is $19.69M, which matches the value for non-discounted costs reported in the Draft Final FFS

- To determine net present value (NPV), a 7.0 percent discount rate is applied to future costs, which is consistent with the discount rate applied in the Draft Final FFS. NPV is calculated by discounting future costs to present-day dollars using the following equation:

$$PV = \frac{FV}{(1+i)^n} = C \times FV$$

  PV is the present value
  FV is the value in year "n" (i.e., future value)
  i is the discount rate
  C is the discount factor, which equals $1/(1+i)^n$

- The NPV calculated by the GSR Team is $14.3M. This is consistent with the NPV reported in the Draft Final FFS ($14.3M) based on the assumption that future costs will be incurred 83.263% into the year as described on the attached cost spreadsheet.

Baseline – P&T System O&M

Scope of Work

The following components of the Assembly Level Data Report included in the Draft Final FFS Appendix C are considered for footprinting the P&T system O&M:

P&T System O&M (initial phase, 5 years)

Note: The quantities listed in the Draft Final FFS for these items are annual. For footprinting, the quantities are multiplied by 5 to account for the 5 years of O&M.

Overnight delivery service, 21 to 50 lb packages .... 5*420 LB
Modular liquid-phase activated carbon, Dual Bed, 2 - 10' Diameter, 350 GPM Series, 700 G ...... 5*0.43 EA
Remove Carbon from Vessels, 10,000 - 20,000 Lb Minimum, Transport & Reactivate .... 5*42867 LB

- Assume used GAC sent to Red Bluff, CA (based on information from Project Team during Step 5 call), ~520 miles one way, once per year

Treatment System Operator .... 1544 HR

- For travel of the system operator and field technicians, Leanna Woods Poon indicated via email that for this 5 year period, 2 people (mobilizing from Seattle) would be working for 10 days 3 times per year, plus an additional 10 days per month for one person (assumed to be the local system operator). The Project Team indicated on Step 5 call that system operator lives 20 miles from site. This description provided by the Project Team will be used to estimate number and length of trips (rather than the number of hours provided by RACER).

Electrical Charge .... 5*19201 KWH
Electrical Charge .... 5*16321 KWH
Electrical Charge .... 5*4801 KWH
Electrical Charge .... 5*162515 KWH
Electrical Charge .... 5*79534 KWH
Electrical Charge .... 5*36001 KWH

Note that if a field technician is listed in the FFS but no vehicle mileage charge is included it is assumed that the field technician will be on-site for other purposes, and the required travel to and from the site is not included in the footprinting for this alternative.

Baseline – P&T System O&M

Input into "Remedial Investigation" tab of SiteWise Input Sheet.xls

- Baseline Information
  - Remedial Investigation Cost
    - Total remedial investigation cost ($) – leave blank in SiteWise

- Material Production
  - Well Materials
  - Treatment Chemicals & Materials
  - Treatment Media
    - Treatment 1 – GAC. 42,867 lbs per year * 5 years = 214,335 lbs total. Select regenerated GAC.
  - Construction Materials
  - Well Decommissioning
  - Bulk Material Quantities

- Transportation
  - Personnel Transportation – Road
    - Trip 1 – Additional field technicians for bio injections during first 5 years. Mobilization from Seattle. Assume car, gasoline. 500 miles round trip. 3 trips per year for 5 years = 15 trips with 2 travelers.
    - Trip 2 – Additional field technicians for bio injections during first 5 years. Trips from local hotel to site (assume 20 miles round trip). Assume car, gasoline. 20 miles round trip, 10 trips 3 times per year for five years = 150 trips total with 2 travelers.
    - Trip 3 – Treatment system operator. Assume car, gasoline. 40 miles round trip, 10 trips per month * 12 months per year for five years = 600 trips total with one traveler.
  - Personnel Transportation – Air
  - Personnel Transportation – Rail
  - Equipment Transportation – Road
    - Trip 1 – GAC transport (delivery off-site for regeneration and replacement delivered to the site). Assume diesel, 1040 miles round trip * 1 trip per year * 5 years (5200 miles total), with a transport weight of 42,867 lbs (42,867/2000 = 21.4335 tons).
  - Equipment Transportation – Air
    - Trip 1 – Overnight delivery service, 21 to 50 lb packages (assumed to be samples sent to lab). Assume one 35 lb package sent 1800 miles one way (to ERDC in Vicksburg, MS, which has been used in the past at this site) each month for 5 years. 1800 miles * 12 months per year * 5 years (108000 miles total), with a transport weight of 35 lbs (35/2000 = 0.0175 tons).
    - Trip 2 – Assumed empty coolers sent to site. Assume one 10 lb package sent 1800 miles one way each month for 5 years. 1800 miles * 12 months per year * 5 years (108000 miles total), with a transport weight of 10 lbs (10/2000 = 0.005 tons).
  - Equipment Transportation – Rail
  - Equipment Transportation – Water

Baseline – P&T System O&M

- Equipment Use
  - Earthwork
  - Drilling
  - Trenching
  - Pump Operation (Electricity Region of "NWPP" is specified on "Site Info" tab of SiteWise)
    - Pump 1 – Used to represent electrical charge for P&T system O&M. Select "Method 1" to directly input electricity use in kWh. 5*19201 = 96005 kWh.
    - Pump 2 – Used to represent electrical charge for P&T system O&M. Select "Method 1" to directly input electricity use in kWh. 5*16321 = 81605 kWh.
    - Pump 3 – Used to represent electrical charge for P&T system O&M. Select "Method 1" to directly input electricity use in kWh. 5*4801 = 24005 kWh.
    - Pump 4 – Used to represent electrical charge for P&T system O&M. Select "Method 1" to directly input electricity use in kWh. 5*162515 = 812575 kWh.
    - Pump 5 – Used to represent electrical charge for P&T system O&M. Select "Method 1" to directly input electricity use in kWh. 5*79534 = 397670 kWh.
    - Pump 6 – Used to represent electrical charge for P&T system O&M. Select "Method 1" to directly input electricity use in kWh. 5*36001 = 180005 kWh.
  - Diesel and Gasoline Pumps
  - Blower, Compressor, Mixer, and Other Equipment
  - Generators
  - Agricultural Equipment
  - Capping Equipment
  - Mixing Equipment
  - Internal Combustion Engines
  - Other Fueled Equipment
  - Operator Labor
  - Laboratory Analysis
  - Other Known Onsite Activities

- Residual Handling
  - Residue Disposal/Recycling
  - Landfill Operations
  - Thermal/Catalytic Oxidizers

- Resource Consumption
  - Water Consumption
  - Onsite Land and Water Resource Consumption

Once SiteWise input is complete, go to "SiteWise_Input Sheet " for overall project and enter information (including Alternative File Name "Baseline"). Then go to "Generate Alternative" tab and click button labeled "Click to generate alternative using previously entered alternative name". Copies of the input and output summary sheets for this alternative are now located in the directory titled "RA_Baseline_NoFR_1". To store the "Remedial Action Investigation.xls" calculation sheet showing detailed calculations, open it in the overall SiteWise project directory when the appropriate input sheet is open, then do a "save as" to put it in the directory for this alternative using a name that

indicates “will not update”. Then open that file and do “data->edit links” and break the links. If the input sheet for this alternative ever changes, then this calculation sheet needs to be re-saved.

To edit input parameters for this alternative, you must go back to the ORIGINAL SiteWise input sheet and import this alternative using the “Do you want to reload a previously saved remedial alternative in the SiteWise input sheet?” field on the “Site Info” tab. After making necessary changes to the input sheet, re-export the alternative by going to the “Generate Alternative” tab and clicking the button labeled “Click to replace an existing alternative with the same name”. Update saved calculation sheets as described above.

Baseline – Remedy Construction and Well Installation

Scope of Work

The following components of the RACER Assembly Level Data Report included in the Draft Final FFS Appendix C are considered for footprinting the remedy construction and well installation:

Extraction Well Installation (2 New EWs)/Associated Piping and Trenching

Mobilize/Demobilize Drilling Rig & Crew .... 1 LS
Field Technician .... 26 HR

- Assume from field technician hours that there are 3 approximately 8-hr days for well installation

12" PVC, Schedule 80, Well Casing .... 220 LF
12" PVC, Schedule 80, Well Screen .... 40 LF
Air Rotary, 16" Dia Borehole (Unconsolidated), 100 ft < Depth <= 500 ft .... 248 LF
12" Well, Portland Cement Grout .... 106 LF

Notes: Trenching dimensions described as 3000' x 2' x 3' and 200' x 2' x 3'
100% of excavated material will be used as backfill

Cat 215, 1.0 CY, Soil, Shallow, Trenching, Excludes Sheeting, Excludes Dewatering .... 666.67 BCY

- Assume 85 HP, equipment weight = 36155.8 lbs (http://www.ritchiespecs.com/specification?type=&category=Hydraulic+Excavator&make=Caterpillar&model=215&modelid=92851)

On-Site Backfill for Large Excavations, Includes Compaction .... 766.67 ECY
Backfill with Crushed Stone .... 111.11 CY
Compaction, subgrade, 18" wide, 8" lifts, walk behind, vibrating plate .... 111.11 ECY
6" PVC, Schedule 80, Connection Piping .... 3000 LF

Cat 215, 1.0 CY, Soil, Shallow, Trenching, Excludes Sheeting, Excludes Dewatering .... 44.44 BCY
On-Site Backfill for Large Excavations, Includes Compaction .... 51.11 ECY
6" Unreinforced Slab on Grade .... 400 SF
6" Stainless Steel Piping, Schedule 10, Type 316, Excludes Joints, Hangers .... 200 LF

Injection Well Installation/Associated Piping and Trenching
Note: In the Draft Final FFS, the following quantities are included as two separate (but identical) listings, one for the initial 2 year period of bioremediation and another for the following 8 year period of bioremediation. For the purpose of SiteWise input, they have been combined. Note that there will still be 2 separate mobilizations for drilling.

6" Stainless Steel, Well Casing .... 2*440 LF
6" Stainless Steel, Well Screen .... 2*80 LF
Air Rotary, 10" Dia Borehole (Unconsolidated), 100 ft < Depth <= 500 ft .... 2*520 LF
Mobilization/Demobilization, Drill Equipment or Trencher, Crew .... 2*1 EA
6" Screen, Filter Pack .... 2*92 LF
Surface Pad, Concrete, 4' x 4' x 4" .... 2*4 EA
6" Well, Portland Cement Grout .... 2*428 LF
3" Carbon Steel Piping .... 2*40 LF
4" High-density Polyethylene, Transfer Pipe .... 2*800 LF

Baseline – Remedy Construction and Well Installation

Cat 215, 1.0 CY, Soil, Shallow, Trenching, Excludes Sheeting, Excludes Dewatering .... 1777.78 BCY
On-Site Backfill for Large Excavations, Includes Compaction .... 2044.44 ECY
Backfill with Crushed Stone .... 296.30 CY
Compaction, subgrade, 18" wide, 8" lifts, walk behind, vibrating plate .... 296.30 ECY

Assume drilling crew, piping, and other materials coming from Tacoma (approximate 270 miles one way) based on information provided by the Project Team during Step 5 call.

Note that if a field technician is listed in the FFS but no vehicle mileage charge is included it is assumed that the field technician will be on-site for other purposes, and the required travel to and from the site is not included in the footprinting for this alternative.

Baseline – Remedy Construction and Well Installation

Input into "Remedial Action Construction" tab of SiteWise Input Sheet.xls

- Baseline Information
  - Remedial Action Construction Cost
    - Total remedial action construction cost ($) – leave blank in SiteWise

- Material Production
  - Well Materials
    - Well Type 1 – Extraction wells. 2 wells, 110 ft casing + 20 ft screen = 130 ft depth for each well. Schedule 80 PVC, 12" diameter.
    - Well Type 2 – Injection wells. 8 wells, 110 ft casing + 20 ft screen = 130 ft depth for each well. Stainless steel (assume Sch 40S), 6" diameter.
    - Well Type 3 – Used for input of PVC connecting pipe for extraction wells. 1 well, 3000 ft, Sch 80 PVC, 6" diameter.
    - Well Type 4 – Used for input of stainless steel piping for extraction wells. 1 well, 200 ft, Sch 10S stainless steel, 6" diameter.
    - Well Type 5 – Used for input of carbon steel piping for injection wells. 2 wells, 40 ft, assume Sch 40 Steel to represent carbon steel, 3" diameter.
    - Well Type 6 – Used for input of high-density polyethylene transfer pipe for injection wells. 2 wells, 800 ft, assume Sch 40 HDPE pipe, 4" diameter.
  - Treatment Chemicals & Materials
  - Treatment Media
  - Construction Materials
    - Material 1 – Used for injection well filter pack. 10" borehole and 6" screen, 23 ft length per well. Use gravel for filter material. Area of material = $\pi 5^2 - \pi 3^2$ = 50.27 square inches = .35 square feet. Depth of material is 184 (total for all 8 wells).
    - Material 2 – Used for injection well concrete surface pads. Select general concrete. Each pad is 4' x 4' x 4', one pad each for 8 wells = 512 cubic feet total for all wells. Enter 16 cubic feet (4' x 4') for area and 32 feet (4' x 8) for depth.
    - Material 3 – Portland cement grout listed under extraction well installation. 16" borehole and 12" well casing, 53 ft length per well. Select typical cement. Area of material = $\pi 8^2 - \pi 6^2$ = 87.96 square inches = .61 square feet. Depth of material is 106 (total for both wells).
    - Material 4 – Portland cement grout listed under injection well installation. 10" borehole and 6" well casing, 107 ft length per well. Area of material = $\pi 5^2 - \pi 3^2$ = 50.27 square inches = .35 square feet. Depth of material is 856 (total for all 8 wells).
    - Material 5 – Unreinforced Slab on Grade. Use general concrete, 400 square ft, 0.5 ft deep.
    - Material 6 – Crush stone for backfill. Use gravel, 111 cubic yards for EWs and 296 cubic yards for IWs = 407 cubic yds. Total = 10989 cubic ft. Assign as 10989 square ft with 1 foot depth.
  - Well Decommissioning
  - Bulk Material Quantities

- Transportation
  - Personnel Transportation – Road

3 separate drilling events – Assume from FFS Appendix C: installation of 2 extraction wells in 3 days; installation of 4 injection wells in one week for 2 yr bio; and installation of additional 4 injection wells in one week for 8 yr bio (occurring several years apart, so 3 distinct mobilizations). Trips are consolidated here to fit within 6 columns for SiteWise input.

- Trip 1 – Light truck supporting drill rig. Light truck, gasoline. 540 miles round trip from Tacoma to site. 3 round trips with one passenger.
- Trip 2 – Light truck supporting drill rig. Light truck, gasoline. Assume 20 miles round trip from local hotel, one round trip per day for the 3+5+5 = 13 days of well installation with 3 passengers.
- Trip 3 – Round-trip for drill rig. Heavy duty, diesel. 540 miles round trip from Tacoma to site. 3 round trips with one passenger.
- Trip 4 – Round-trip for heavy duty truck supporting drill rig. Heavy duty, diesel. 540 miles round trip from Tacoma to site. 3 round trips with one passenger.

- Personnel Transportation – Air
- Personnel Transportation – Rail
- Equipment Transportation – Road
  - Trip 1 – Transport Cat 215 excavator to site. Diesel. Assume 60 miles round trip (30 miles each way) dropping off and picking up from site * 3 trenching events (separate events for extraction well installation, 2yr bio injection well installation, and 8 yr bio injection well installation) (empty return trips included below). Assume weight = 36155.8 lbs/2000 = 18.1 tons.
  - Trip 2 – Transport of extraction well casing, associated materials, and piping to site. Diesel. 270 miles one way from Tacoma. Use remedial action construction output file to determine pipe and material weight. (4520 lbs + 16830 lbs + 1868 lbs + (2757.4 kg + 13427.9 kg)*2.2)/2000 = 29.41 tons.
  - Trip 3 – Transport of injection well casing, associated materials, and piping to site. Diesel. 270 miles one way from Tacoma * 2 for separate deliveries for 2yr and 8yr bio. Use remedial action construction output file to determine pipe weight, which will be half of the combined weights for “well type 2”, “well type 5”, and “well type 6” because SiteWise input for piping was combined for 2yr and 8yr bio well installation events, and add materials weights, which will also be half of the combined weights for materials 1, 2, and 4 because of combined input. (19777 lbs + 607 lbs + 2638 lbs + (3067.3kg + 34375.3kg + 12776.5kg) * 2.2)/2/2000 = 33.38 tons per delivery.
  - Trip 4 – Transport of crushed stone. Use remedial action construction output file to determine weight. 576 tons. Assume 60 miles round trip (30 miles each way). Since the weight limit for an on-road truck load in SiteWise is 40 tons, the total distance traveled must be increased to account for the additional trucks needed to transport material (assume full loads). The 30 mile trip was multiplied by 576/40 (or 14 rips) for a total of 420 mile traveled with 40 ton loads.
  - Trip 5 – Empty return trips for Trips 1 – 3 above. 30*3 + 270 + 540 + 30*14 = 1320 miles total. Enter 0 tons.
- Equipment Transportation – Air
- Equipment Transportation – Rail

- Equipment Transportation – Water

- Equipment Use
  - Earthwork
    - Equipment 1 – Cat 215 excavator, extraction well trenching. Select excavator, diesel. 666.67 + 44.44 cubic yards (combined 2 entries) = 711.11 cubic yards to be moved.
    - Equipment 2 – Cat 215 excavator, extraction well backfill. Select excavator, diesel. 766.67 + 51.11 + 111.11 (combined 3 entries) = 928.89 cubic yards to be backfilled.
    - Equipment 3 – Cat 215 excavator, injection well trenching. Select excavator, diesel. 1777.78 * 2 = 3556 cubic yards to be moved.
    - Equipment 4 – Cat 215 excavator, injection well backfill. Select excavator, diesel. (2044.44 + 296.30) * 2 = 4681 cubic yards to be backfilled.
  - Drilling
    - Event 1 – Extraction well installation. 2 wells, air rotary drilling, assume 12 hours per well (from field technician hours), diesel fuel.
    - Event 2 – Injection well installation (2 yr bio). 4 wells, air rotary drilling, assume 10 hours per well, diesel.
    - Event 3 – Injection well installation (8 yr bio). 4 wells, air rotary drilling, assume 10 hours per well, diesel.
  - Trenching
    - Trencher 1 – Used to represent vibrating plate compactor for extraction well trenching. Select gasoline, 3 to 6 HP, assume 2 hours of operation.
    - Trencher 2 – Used to represent vibrating plate compactor for extraction well trenching. Select gasoline, 3 to 6 HP, assume 4 hours of operation.
  - Pump Operation
  - Diesel and Gasoline Pumps
  - Blower, Compressor, Mixer, and Other Equipment
  - Generators
  - Agricultural Equipment
  - Capping Equipment
  - Mixing Equipment
  - Internal Combustion Engines
  - Other Fueled Equipment
  - Operator Labor
  - Laboratory Analysis
  - Other Known Onsite Activities

- Residual Handling
  - Residue Disposal/Recycling
  - Landfill Operations
  - Thermal/Catalytic Oxidizers

- Resource Consumption
  - Water Consumption
  - Onsite Land and Water Resource Consumption

Baseline – Remedy Construction and Well Installation

Once SiteWise input is complete, go to "SiteWise_Input Sheet" for overall project and enter information (including Alternative File Name "Baseline"). Then go to "Generate Alternative" tab and click button labeled "Click to generate alternative using previously entered alternative name". Copies of the input and output summary sheets for this alternative are now located in the directory titled "RA_Baseline_NoFR_1". To store the "Remedial Action Construction.xls" calculation sheet showing detailed calculations, open it in the overall SiteWise project directory when the appropriate input sheet is open, then do a "save as" to put it in the directory for this alternative using a name that indicates "will not update". Then open that file and do "data->edit links" and break the links. If the input sheet for this alternative ever changes, then this calculation sheet needs to be re-saved.

To edit input parameters for this alternative, you must go back to the ORIGINAL SiteWise input sheet and import this alternative using the "Do you want to reload a previously saved remedial alternative in the SiteWise input sheet?" field on the "Site Info" tab. After making necessary changes to the input sheet, re-export the alternative by going to the "Generate Alternative" tab and clicking the button labeled "Click to replace an existing alternative with the same name". Update saved calculation sheets as described above.

Baseline – Bioremediation (Including Studies and Testing)

Scope of Work

The following components of the RACER Assembly Level Data Report included in the Draft Final FFS Appendix C are considered for footprinting the bioremediation (including studies and testing, but not labor for limited Bio in first 5 yrs which is lumped with P&T O&M):

LAPP-2 Study

Rail and Tanker Truck Transportation for Corn Syrup ....944 CWT

- Assume 2400 miles of rail transport from supplier in Tennessee to Seattle, and 250 miles of truck transport from Seattle to Umatilla. 944 CWT = 94,400 lbs.

Food Grade Starch Bioremediation Substrate .... 94400 LB

- SiteWise does not have conversion factors for corn syrup, so vegetable oil will be used as a surrogate throughout, since it is assumed to have a similar environmental footprint.

Injection Well Tests (2)

Note: In the Draft Final FFS, the following quantities are included as two separate (but identical) listings, one for each injection well test. For footprinting purposes, these separate entries have been combined as listed below. Assuming they will be installed at the same time, only one mobilization for drilling will be footprinted.

Rail and Tanker Truck Transportation ....2*1531 CWT
Non Haz Drummed Site Waste - Load, Transp, & Landfill Disp (55-Gal Drums) ....2*50 EA
6" Stainless Steel, Well Casing ....2*110 LF
6" Stainless Steel, Well Screen ....2*20 LF
Air Rotary, 10" Dia Borehole (Unconsolidated), 100 ft < Depth <= 500 ft ....2*130 LF
Mobilization/Demobilization, Drill Equipment or Trencher, Crew ....1 EA
6" Screen, Filter Pack ....2*23 LF
Surface Pad, Concrete, 4' x 4' x 4" ....2*1 EA
6" Well, Portland Cement Grout ....2*107 LF
3" Carbon Steel Piping ....2*10 LF
6" High-density Polyethylene, Transfer Pipe ....2*200 LF
Food Grade Starch Bioremediation Substrate .... 2*153122 LB

Lagoon Injections (total for initial 5 years of injections during continued P&T)

Rail and Tanker Truck Transportation ....14425 CWT
Non Haz Drummed Site Waste - Load, Transp, & Landfill Disp (55-Gal Drums) ....60 EA
Food Grade Starch Bioremediation Substrate .... 1442550 LB

Plume Injections (total for first 2 years of full-scale bio)

Rail and Tanker Truck Transportation ....97999 CWT
Non Haz Drummed Site Waste - Load, Transp, & Landfill Disp (55-Gal Drums) ....180 EA
Food Grade Starch Bioremediation Substrate .... 9799968 LB

Baseline – Bioremediation (Including Studies and Testing)

Plume Injections (total for subsequent 8 years of full-scale bio)

Rail and Tanker Truck Transportation ....48999 CWT
Non Haz Drummed Site Waste - Load, Transp, & Landfill Disp (55-Gal Drums) .... 360 EA
Food Grade Starch Bioremediation Substrate .... 4899984 LB

Well Network O&M for 10 Years
Note: The quantities listed in the Draft Final FFS are annual for the entire 10 years of full-scale bio, so each quantity is multiplied by 10 to account for the full 10 years of bio.

Treatment System Operator ....10*1015 HR

- Leanna Woods Poon indicated via email that for the 10 years of full-scale bio, 2 people (mobilizing from Seattle) would be working for 33 days 3 times per year for the first 2 years, then 2 people (mobilizing from Seattle) would be working for 33 days 2 times per year for the next 4 years, then 2 people (mobilizing from Seattle) would be working for 33 days 1 time per year for the next 4 years, plus an additional 1 day per month for one person for the entire 10 year period (assumed to be the local system operator). The Project Team indicated on Step 5 call that system operator lives 20 miles from site. This description provided by the project team will be used to estimate number and length of trips (rather than the number of hours provided by RACER).

Electrical Charge .... 10*6681 KWH
Electrical Charge .... 10*61496 KWH
Electrical Charge .... 10*18449 KWH
Electrical Charge .... 10*22269 KWH

Note that if a field technician is listed in the FFS but no vehicle mileage charge is included it is assumed that the field technician will be on-site for other purposes, and the required travel to and from the site is not included in the footprinting for this alternative.

Baseline – Bioremediation (Including Studies and Testing)

Input into "Remedial Action Operations" tab of SiteWise Input Sheet.xls

- Baseline Information
  - Remedial Action Operations Cost and Duration
    - Total remedial action operations cost ($) – leave blank in SiteWise
    - Duration of remedial action operations (unit time) – 1 yr for this GSR evaluation because we have multiplied input items by number of years as part of the input

- Material Production
  - Well Materials
    - Well Type 1 – Well casing/screen for injection well tests. 2 wells, 110 ft casing + 20 ft screen = 130 ft depth for each well. Stainless steel (assume Sch 40S), 6" diameter.
    - Well Type 2 – Used for input of carbon steel piping for injection well tests. 2 wells, 10 ft, assume Sch 40 Steel to represent carbon steel, 3" diameter.
    - Well Type 3 – Used for input of high-density polyethylene transfer pipe for injection well tests. 2 wells, 200 ft, assume Sch 40 HDPE pipe, 6" diameter.
  - Treatment Chemicals & Materials
  - Treatment Media
  - Construction Materials
    - Material 1 – Used for test injection well filter pack. 10" borehole and 6" screen, 23 ft length per well. Use gravel for filter material. Area of material = $\pi 5^2 - \pi\ 3^2$ = 50.27 square inches = .35 square feet. Depth of material is 46 (total for both wells).
    - Material 2 – Used for test injection well concrete surface pads. Select general concrete. Each pad is 4' x 4' x 4', one pad each for 2 wells = 128 cubic feet total. Enter 16 cubic feet (4' x 4') for area and 8 feet (4' x 2) for depth.
    - Material 3 – Portland cement grout listed under injection well installation. 10" borehole and 6" well casing, 107 ft length per well. Area of material = $\pi 5^2 - \pi\ 3^2$ = 50.27 square inches = .35 square feet. Depth of material is 214 (total for both wells).
  - Well Decommissioning
  - Bulk Material Quantities
    - Material 1 – Food grade starch bioremediation substrate (corn syrup) for LAPP-2 Study. Use vegetable oil to represent corn syrup. 94,400 lbs.
    - Material 2 – Corn syrup for injection well tests. Use vegetable oil to represent corn syrup. 153,122 lbs * 2 tests = 306,244 lbs.
    - Material 3 – Corn syrup for lagoon injections (initial phase, 5 year total). Use vegetable oil to represent corn syrup. 1,442,550 lbs.
    - Material 4 – Corn syrup for plume injections (full-scale bio, first 2 year total). Use vegetable oil to represent corn syrup. 9,799,968 lbs.
    - Material 5 – Corn syrup for plume injections (full-scale bio, next 8 year total). Use vegetable oil to represent corn syrup. 4,899,984 lbs.
- Transportation
  - Personnel Transportation – Road
    - Trip 1 – Light truck supporting drill rig. Light truck, gasoline. 540 miles round trip from Tacoma to site. 1 round trip with one passenger.

    - Trip 2 – Light truck supporting drill rig. Light truck, gasoline. Assume 20 miles round trip from local hotel, one round trip per day for the 2 days of well installation with 3 passengers.
    - Trip 3 – Round-trips for drill rig and heavy duty truck supporting drill rig (combined for SiteWise entry). Heavy duty, diesel. 540 miles round trip from Tacoma to site * 2 vehicles = 1080 miles. Enter 1 round trip with 1 passenger.
    - Trip 4 – Additional field technicians for bio injections during 10 years of full-scale bio. Mobilization from Seattle. Assume car, gasoline. 500 miles round trip. 3 trips per year * 2 years + 2 trips per year * 4 years + 1 trip per year * 4 years = 18 trips with 2 travelers.
    - Trip 5 – Additional field technicians for bio injections during 10 years of full-scale bio. Trips from local hotel to site (assume 20 miles round trip). Assume car, gasoline. 20 miles round trip, 33 trips * 3 events per year * 2 years + 33 trips * 2 events per year * 4 years + 33 trips * 1 event per year * 4 years = 594 trips total with 2 travelers.
    - Trip 6 – Treatment system operator. Assume car, gasoline. 40 miles round trip, 1 trip * 12 times per year * 10 years = 120 trips total with one traveler.
- Personnel Transportation – Air
- Personnel Transportation – Rail
- Equipment Transportation – Road
    - Trip 1 – Transport of test injection well casing, associated materials, and piping to site. Diesel. 270 miles one way from Tacoma. Use remedial action operation output file to determine pipe and material weight. (4944 lbs + 152 lbs + 978 lbs + (766.8 kg + 8593.8 kg + 3194.1 kg)*2.2)/2000 = 15.59 tons.
    - Trip 2 – Corn syrup transport from Seattle to Umatilla. 250 miles one way from Seattle. Total mass to be transported over 15 yr remedy duration is 47.2 tons + 153.1 tons + 721.3 tons + 4900.0 tons + 2450.0 tons = 8271.6 tons. Since the weight limit for an on-road truck load in SiteWise is 40 tons, the total distance traveled must be increased to account for the additional trucks needed to transport material (assume full loads). The 250 mile trip was multiplied by 8271.6/40 (or 206.79 trips) for a total of 51697.5 mile traveled with 40 ton loads.
    - Trip 3– Empty return trips. Total empty miles for the trips above are 270 mi + 51697.5 = 51967.5
- Equipment Transportation – Air
- Equipment Transportation – Rail
    - Trip 1 – Corn syrup transport from Tennessee to Seattle (LAPP-2 Study). Assume 2400 miles. 94400 lbs / 2000 = 47.2 tons.
    - Trip 2 – Corn syrup transport from Tennessee to Seattle (Injection Well Tests). Assume 2400 miles. 2*153122 lbs / 2000 = 153.1 tons.
    - Trip 3 – Corn syrup transport from Tennessee to Seattle (Lagoon Injections). Assume 2400 miles. 1442550 lbs / 2000 = 721.3 tons.
    - Trip 4 – Corn syrup transport from Tennessee to Seattle (Plume Injections, 2yr). Assume 2400 miles. 9799968 lbs / 2000 = 4900.0 tons.
    - Trip 5 – Corn syrup transport from Tennessee to Seattle (Plume Injections, 8yr). Assume 2400 miles. 4899984 lbs / 2000 = 2450.0 tons.
- Equipment Transportation – Water

Baseline – Bioremediation (Including Studies and Testing)

- Equipment Use
    - Earthwork
    - Drilling
        - Event 1 – Test injection well installation. 2 wells, air rotary drilling, assume 10 hours per well, diesel.
    - Trenching
    - Pump Operation (Electricity Region of "NWPP" is specified on "Site Info" tab of SiteWise)
        - Pump 1 – Used to represent electrical charge for Well Network O&M. Select "Method 1" to directly input electricity use in kWh. 10*6681 = 66810 kWh.
        - Pump 2 – Used to represent electrical charge for Well Network O&M. Select "Method 1" to directly input electricity use in kWh. 10*61496 = 614960 kWh.
        - Pump 3 – Used to represent electrical charge for Well Network O&M. Select "Method 1" to directly input electricity use in kWh. 10*18449 = 184490 kWh.
        - Pump 4 – Used to represent electrical charge for Well Network O&M. Select "Method 1" to directly input electricity use in kWh. 10*22269 = 222690 kWh.
    - Diesel and Gasoline Pumps
    - Blower, Compressor, Mixer, and Other Equipment
    - Generators
    - Agricultural Equipment
    - Capping Equipment
    - Mixing Equipment
    - Internal Combustion Engines
    - Other Fueled Equipment
    - Operator Labor
    - Laboratory Analysis
    - Other Known Onsite Activities

- Residual Handling
    - Residue Disposal/Recycling
        - Soil Residue – 55 gallon drum disposal for injection well tests. Assume 55 gallon drums contain mostly purge water and possibly some heavier material. Water is 8.33 lbs per gallon, so assume each drum is ~500 lbs. 500 lbs * 100 drums = 50,000 lbs/2000 = 25 tons transported. Assume diesel, 1 trip, 50 miles 1 way.
        - Residual water – 55 gallon drum disposal for 5 years of lagoon injections. Assume 55 gallon drums contain mostly purge water and possibly some heavier material. Water is 8.33 lbs per gallon, so assume each drum is ~500 lbs. 500 lbs * 60 drums = 30,000 lbs/2000 = 15 tons transported. Assume 1 trip per year to transport waste off-site, which would equate to 3 tons per trip. Assume diesel, 5 trips, 50 miles 1 way.
        - Material Residue – 55 gallon drum disposal for first 2 years of plume injections. Assume 55 gallon drums contain mostly purge water and possibly some heavier material. Water is 8.33 lbs per gallon, so assume each drum is ~500 lbs. 500 lbs * 180 drums = 90,000 lbs/2000 = 45 tons transported. Assume 1 trip per year to transport waste off-site, which would equate to 22.5 tons per trip. Assume diesel, 2 trips, 50 miles 1 way.
        - Other Residue – 55 gallon drum disposal for next 8 years of plume injections. Assume 55 gallon drums contain mostly purge water and possibly some heavier

material. Water is 8.33 lbs per gallon, so assume each drum is ~500 lbs. 500 lbs * 360 drums = 180,000 lbs/2000 = 90 tons transported. Assume 1 trip per year to transport waste off-site, which would equate to 11.25 tons per trip. Assume diesel, 8 trips, 50 miles 1 way.

    - Other Residue – Empty trips to site for all of the above trips. Enter 0 for weight and diesel for fuel. Sum number of trips from above (1+5+2+8 = 16), 50 miles 1 way.
  - Landfill Operations
  - Thermal/Catalytic Oxidizers

- Resource Consumption
  - Water Consumption
  - Onsite Land and Water Resource Consumption

Once SiteWise input is complete, go to "SiteWise_Input Sheet" for overall project and enter information (including Alternative File Name "Baseline"). Then go to "Generate Alternative" tab and click button labeled "Click to generate alternative using previously entered alternative name". Copies of the input and output summary sheets for this alternative are now located in the directory titled "RA_Baseline_NoFR_1". To store the "Remedial Action Operations.xls" calculation sheet showing detailed calculations, open it in the overall SiteWise project directory when the appropriate input sheet is open, then do a "save as" to put it in the directory for this alternative using a name that indicates "will not update". Then open that file and do "data->edit links" and break the links. If the input sheet for this alternative ever changes, then this calculation sheet needs to be re-saved.

To edit input parameters for this alternative, you must go back to the ORIGINAL SiteWise input sheet and import this alternative using the "Do you want to reload a previously saved remedial alternative in the SiteWise input sheet?" field on the "Site Info" tab. After making necessary changes to the input sheet, re-export the alternative by going to the "Generate Alternative" tab and clicking the button labeled "Click to replace an existing alternative with the same name". Update saved calculation sheets as described above.

Baseline – Monitoring and 5-Year Reviews

<u>Scope of Work</u>

The following components of the RACER Assembly Level Data Report included in the Draft Final FFS Appendix C are considered for footprinting the monitoring and 5-year reviews:

<u>Single Monitoring Event during RA (2 week event requiring 2 people)</u>

Sample collection, vehicle mileage charge, car or van .... 1300 MI
Overnight delivery service, 51 to 70 lb packages .... 840 LB

- Assume 14 coolers at 60 lbs each (full) are sent 1800 miles from site to lab. Assume 14 coolers at 10 lbs each (empty) sent 1800 miles from lab to site.

<u>Monitoring for Initial 5 Years of P&T and bio injections (3 events per year, 2 weeks per event, requiring 2 people)</u>

Note: The quantities listed in the Draft Final FFS are annual. For footprinting, the quantities are multiplied by 5 to account for the 5 years of monitoring.

Sample collection, vehicle mileage charge, car or van .... 5*3900 MI
Overnight delivery service, 51 to 70 lb packages .... 5*2460 LB

<u>Monitoring for First 2 Years of Full-Scale Bio (3 events per year, 2 weeks per event, requiring 2 people)</u>

Note: The quantities listed in the Draft Final FFS are annual. For footprinting, the quantities are multiplied by 2 to account for the 2 years of monitoring.

Sample collection, vehicle mileage charge, car or van .... 2*3900 MI
Overnight delivery service, 51 to 70 lb packages .... 2*2460 LB

<u>Monitoring for Subsequent 8 Years of Full-Scale Bio (2 events per year, 2 weeks per event, requiring 2 people)</u>

Note: The quantities listed in the Draft Final FFS are annual. For footprinting, the quantities are multiplied by 8 to account for the 8 years of monitoring.

Sample collection, vehicle mileage charge, car or van .... 8*2600 MI
Overnight delivery service, 51 to 70 lb packages .... 8*1680 LB

<u>Five Year Reviews (2 people per site visit, $500 each allotted for plane ticket)</u>

Note: The quantities listed in the Draft Final FFS are for one 5-year review. For footprinting, the quantities are multiplied by 3 to account for the 3 anticipated 5-year reviews during the 15 year period of remedial action.

Sedan, Automobile, Rental .... 3*3 DAY
Airfare .... 3*2 LS

Note that if a field technician is listed in the FFS but no vehicle mileage charge is included it is assumed that the field technician will be on-site for other purposes, and the required travel to and from the site is not included in the footprinting for this alternative.

Baseline – Monitoring and 5-Year Reviews

<u>Input into "Longterm Monitoring" tab of SiteWise Input Sheet.xls</u>

- Baseline Information
  - Longterm Monitoring Cost and Duration
    - Total remedial action operations cost ($) – leave blank in SiteWise
    - Duration of Longterm Monitoring (unit time) – 1 yr for this GSR evaluation because we have multiplied input items by number of years as part of the input

- Material Production
  - Well Materials
  - Treatment Chemicals & Materials
  - Treatment Media
  - Construction Materials
  - Well Decommissioning
  - Bulk Material Quantities

- Transportation
  - Personnel Transportation – Road
    - Trip 1 – Sample collection during RA. Select SUV (mileage in between car and van), gasoline. 1300 miles, 1 trip, 2 travelers.
    - Trip 2 – Sample collection during initial 5 yr monitoring. Select SUV (mileage in between car and van), gasoline. 3900 miles, 5 trips, 2 travelers.
    - Trip 3 – Sample collection during 2 yr bio monitoring. Select SUV (mileage in between car and van), gasoline. 3900 miles, 2 trips, 2 travelers.
    - Trip 4 – Sample collection during 8 yr bio monitoring. Select SUV (mileage in between car and van), gasoline. 2600 miles, 8 trips, 2 travelers.
    - Trip 5 – Five year reviews. Select car, gasoline. Assume 20 miles round trip from local hotel to site, 3 days per site visit * 3 reviews over 15yr remedy period = 9 trips total, 2 travelers.
  - Personnel Transportation – Air
    - Trip 1 – Five year reviews. Assume 500 miles traveled per round trip flight per traveler, 2 travelers, 3 round trip flights.
  - Personnel Transportation – Rail
  - Equipment Transportation – Road
  - Equipment Transportation – Air
    - Trip 1 – Monitoring during RA, overnight delivery service, 51 to 70 lb packages (assumed to be samples sent to lab). Assume 14 coolers, 35 lbs average weight (10 lbs empty and 60 lbs full) each, sent 3600 miles round trip to ERDC, a previously used lab in Vicksburg, MS (assumed). 3600 miles, with a transport weight of 35 lbs * 14 coolers / 2000 = 0.245 tons.
    - Trip 2 – Initial 5 yr monitoring, overnight delivery service, 51 to 70 lb packages (assumed to be samples sent to lab). Assume 41 coolers per year for 5 years, 35 lbs average weight (10 lbs empty and 60 lbs full) each, sent 3600 miles round trip. 3600 miles, with a transport weight of 35 lbs * 41 coolers * 5 yrs / 2000 = 3.59 tons.
    - Trip 3 – 2 yr bio monitoring, overnight delivery service, 51 to 70 lb packages (assumed to be samples sent to lab). Assume 41 coolers per year for 2 years, 35 lbs average weight (10 lbs empty and 60 lbs full) each, sent 3600 miles round

trip. 3600 miles, with a transport weight of 35 lbs * 41 coolers * 2 yrs / 2000 = 1.44 tons.

    - Trip 4 – 8 yr bio monitoring, overnight delivery service, 51 to 70 lb packages (assumed to be samples sent to lab). Assume 28 coolers per year for 8 years, 35 lbs average weight (10 lbs empty and 60 lbs full) each, sent 3600 miles round trip. For SiteWise input, assume diesel, 3600 miles, with a transport weight of 35 lbs * 28 coolers * 8 yrs / 2000 = 3.92 tons.
  - Equipment Transportation – Rail
  - Equipment Transportation – Water

- Equipment Use
  - Earthwork
  - Drilling
  - Trenching
  - Pump Operation
  - Diesel and Gasoline Pumps
  - Blower, Compressor, Mixer, and Other Equipment
  - Generators
  - Agricultural Equipment
  - Capping Equipment
  - Mixing Equipment
  - Internal Combustion Engines
  - Other Fueled Equipment
  - Operator Labor
  - Laboratory Analysis
  - Other Known Onsite Activities

- Residual Handling
  - Residue Disposal/Recycling
  - Landfill Operations
  - Thermal/Catalytic Oxidizers

- Resource Consumption
  - Water Consumption
  - Onsite Land and Water Resource Consumption

Once SiteWise input is complete, go to "SiteWise_Input Sheet" for overall project and enter information (including Alternative File Name "Baseline"). Then go to "Generate Alternative" tab and click button labeled "Click to generate alternative using previously entered alternative name". Copies of the input and output summary sheets for this alternative are now located in the directory titled "RA_Baseline_NoFR_1". To store the "Longterm Monitoring.xls" calculation sheet showing detailed calculations, open it in the overall SiteWise project directory when the appropriate input sheet is open, then do a "save as" to put it in the directory for this alternative using a name that indicates "will not update". Then open that file and do "data->edit links" and break the links. If the input sheet for this alternative ever changes, then this calculation sheet needs to be re-saved.

Baseline – Monitoring and 5-Year Reviews

To edit input parameters for this alternative, you must go back to the ORIGINAL SiteWise input sheet and import this alternative using the "Do you want to reload a previously saved remedial alternative in the SiteWise input sheet?" field on the "Site Info" tab. After making necessary changes to the input sheet, re-export the alternative by going to the "Generate Alternative" tab and clicking the button labeled "Click to replace an existing alternative with the same name". Update saved calculation sheets as described above.

Other Supporting Calculations:
Pump & Treat System Expansion and Bioremediation (Alternative 4, Baseline)

% of Total Energy Usage from Renewable Resources

- According to eGRID (http://cfpub.epa.gov/egridweb/view_srl.cfm), the percentage of electricity from renewable sources for region NWPP is 50.93% (most of which is hydropower). Thus, it is assumed that 50.93% of the on-site electricity use is from renewable resources. The on-site electrical use is estimated at 27,720 MMBTU in SiteWise. The total energy use (on-site and off-site) is estimated at 102,851 MMBTU. Assuming all fuels used and all other energy use for production of materials are from non-renewable sources, then the % of total energy from renewable sources is 27,200 *.5093 / 102,851 = 13.7%.

Hazardous Air Pollutants

- None identified

Refined Materials Use

Material	Lbs	Basis
Corn Syrup	16,543,146	LAPP-2 study: 94,400 lbs Inj. Tests: 306,244 lbs First 5 yrs: 1,442,550 lbs 2 Yrs Full Bio: 9,799,968 lbs 8 yrs Full Bio: 4,899,984
PVC	21,350	From SiteWise: 2 new EWs – 4,520 lbs Connecting pipe for new EWs – 16,830 lbs
Steel	758	From SiteWise: New IWs – 606 lbs Inj Test wells – 152 lbs
Stainless Steel	26,589	From SiteWise: EW piping – 1,868 lbs New IWs – 19,777 lbs Inj Test wells – 4,944 lbs
Cement	41,201	From SiteWise: 2 new EWs: 2,757 kg = 6,065 lbs New IWs: 12,777 kg = 28,109 lbs Inj well tests : 3,194 kg = 7,027 lbs
HDPE Pipe	3,616	From SiteWise: New IWs: 2,638 lbs Inj well tests : 978 lbs

Baseline – Other Supporting Calculations

Material	Lbs	Basis
Concrete	124,074	From SiteWise: 2 new EWs (slab): 13,428 kg = 29,542 lbs New IWs (pads): 34,375 kg = 75,625 lbs Inj well tests (pads): 8,594 kg = 18,907 lbs
GAC	214,335	P&T: 42,867 lbs/yr * 5 yrs
Total	***16,975,069 lbs***	

Unrefined Materials Use

Material	Tons	Basis
Gravel/crushed stone	580	From SiteWise: Backfill for EWs and IWs: 523,394kg = 576 tons New IWs filter pack: 3,067 kg = 3 tons Inj well tests filter pack: 767 kg = 1 ton

Tons of Non-Hazardous Waste

- 175 tons based on transport of 55-gallon drums assumed in RACER assuming 8.33 lbs per gallon of waste

Tons of Hazardous Waste

- None identified

% of Potential Waste Recycled

- The GAC (used in the first five years) is recycled and is therefore not disposed. The estimate of GAC transported is 107 tons over 5 years. Other waste (above) is 175 tons. Therefore, the % of potential waste recycles is 107 / (107 + 175) = 38%

Risks to On-Site Workers and from Transportation

- Based on SiteWise output
    - On-Site worker injuries or fatalities = 0.005
    - Transportation related injuries or fatalities = 0.198

Heavy Truck Trips through Residential Areas

- None identified because residences are sparse and major roads lead to the site.

Project: GSR Pilot for Umatilla
Option or Alternative: Baseline Option (Alternative 4)
Current Date: 2/7/2012

year	capital cost*	annual cost*	present value of cost each year	cumulative cash flow	
	(no discounting)	(no discounting)	7%	no discounting	7%
0	$4,059,539	$430,903	$4,490,443	$4,490,443	$4,490,443
1	$426,199	$644,378	$945,732	$5,561,019	$5,436,175
2	$0	$680,015	$561,417	$6,241,035	$5,997,591
3	$0	$631,614	$487,343	$6,872,649	$6,484,934
4	$528,032	$631,614	$836,228	$8,032,295	$7,321,162
5	$5,215,057	$334,233	$3,739,837	$13,581,585	$11,060,999
6	$0	$360,994	$227,369	$13,942,579	$11,288,369
7	$3,025,979	$360,683	$1,993,515	$17,329,241	$13,281,884
8	$0	$267,579	$147,203	$17,596,819	$13,429,087
9	$0	$254,815	$131,010	$17,851,634	$13,560,097
10	$0	$254,815	$122,439	$18,106,450	$13,682,536
11	$0	$254,815	$114,429	$18,361,265	$13,796,966
12	$0	$303,216	$127,257	$18,664,481	$13,924,223
13	$0	$254,815	$99,947	$18,919,296	$14,024,170
14	$0	$254,815	$93,408	$19,174,111	$14,117,578
15	$0	$514,318	$176,201	$19,688,429	$14,293,780
16	$0	$0	$0	$19,688,429	$14,293,780
17	$0	$0	$0	$19,688,429	$14,293,780
18	$0	$0	$0	$19,688,429	$14,293,780
19	$0	$0	$0	$19,688,429	$14,293,780
20	$0	$0	$0	$19,688,429	$14,293,780
21	$0	$0	$0	$19,688,429	$14,293,780
22	$0	$0	$0	$19,688,429	$14,293,780
23	$0	$0	$0	$19,688,429	$14,293,780
24	$0	$0	$0	$19,688,429	$14,293,780
25	$0	$0	$0	$19,688,429	$14,293,780
26	$0	$0	$0	$19,688,429	$14,293,780
27	$0	$0	$0	$19,688,429	$14,293,780
28	$0	$0	$0	$19,688,429	$14,293,780
29	$0	$0	$0	$19,688,429	$14,293,780
30	$0	$0	$0	$19,688,429	$14,293,780

*positive dollar value is a "cost", negative dollar value is a "savings"

Net Present Value (NPV)-> $14,293,780

Total of capital costs (undiscounted) -> $13,254,805
Total of annual costs (undiscounted) -> $6,433,624

**Costs identified as capital (no discounting) and annual (no discounting) are based on spreadsheet "Cost Summary_Alt 4_7-31-11.xlsx" provided by Project Team. Note that the calculation of present value each year presented above differs slightly from that in the RACER calculations used by the Project Team. This is because, in RACER, different costs are assigned as being incurred during different portions of specific years and that level of detail cannot be reproduced in the values presented above. In the calculations presented above, other than the capital costs incurred in year 0, the present value of future capital and annual costs are assumed to be incurred 83.263% into the year. This assumption allowed the present value for the overall project calculated above to equal the present value calculated for the overall project in the Project Team's RACER calculations.*

GSR Team Calculations to Split Energy Results from SiteWise into "Direct" and "Indirect"
Altrenative 4 (Baseline)

phase	Reported by SiteWise: activity	Reported by SiteWise: energy used (MMBTU)	Assigned by GSR Team from SiteWise Output: Scope 1 (direct) energy used (MMBTU)	Scope 2 (indirect) energy used (MMBTU)	Scope 3 (indirect) energy used (MMBTU)	Total Calculated by GSR Team
Personnel Transportation – Uses "Remedial Investigation" tab	Consumables	2054.89	0.00	0.00	2054.89	2054.89
	Transportation-Personnel	165.38	0.00	0.00	165.38	165.38
	Transportation-Equipment	159.04	0.00	0.00	159.04	159.04
	Equipment Use and Misc	16459.60	5485.98	10973.62	0.00	16459.60
	Residual Handling	0.00	0.00	0.00	0.00	0.00
	Sub-Total	18838.91	5485.98	10973.62	2379.31	18838.91
Equipment and Materials Transportation and Use – Uses "Remedial Action Construction" tab	Consumables	1512.39	0.00	0.00	1512.39	1512.39
	Transportation-Personnel	72.82	0.00	0.00	72.82	72.82
	Transportation-Equipment	70.48	0.00	0.00	70.48	70.48
	Equipment Use and Misc	438.66	355.32	0.00	83.35	438.66
	Residual Handling	0.00	0.00	0.00	0.00	0.00
	Sub-Total	2094.36	355.32	0.00	1739.05	2094.36
Electricity Use – Uses "Remedial Action Operations" tab	Consumables	60634.44	0.00	0.00	60634.44	60634.44
	Transportation-Personnel	146.96	0.00	0.00	146.96	146.96
	Transportation-Equipment	9162.97	0.00	0.00	9162.97	9162.97
	Equipment Use and Misc	11327.47	3808.20	7506.37	12.91	11327.47
	Residual Handling	32.24	0.00	0.00	32.24	32.24
	Sub-Total	81304.08	3808.20	7506.37	69989.52	81304.08
Disposal – Uses "Longterm Monitoring" tab	Consumables	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	295.53	0.00	0.00	295.53	295.53
	Transportation-Equipment	317.78	0.00	0.00	317.78	317.78
	Equipment Use and Misc	0.00	0.00	0.00	0.00	0.00
	Residual Handling	0.00	0.00	0.00	0.00	0.00
	Sub-Total	613.31	0.00	0.00	613.31	613.31
total		102850.66	9649.50	18479.98	74721.18	102850.66

Note: Electricity use reported by SiteWise Version 2.0 in units of kWh is "Direct Scope 1", meaning it is energy consumed at the location of the project. However, energy use associated with electricity reported by SiteWise in units of MMBtu is a life-cycle value which also includes a factor to account for energy used elsewhere required to generate the electricity ("Indirect Scope 2"). Here, 33% of the life-cycle value reported by SiteWise is considered to be "Scope 1" on-site energy use, and 67% is considered to be "Scope 2" energy used in electricity generation.

SiteWise Version 2.0 uses fuel energy values from U.S. Department of Energy, Argonne National Laboratory, Transportation Technology R&D Center, GREET 1.8d.1, Fuel-Cycle model, 2010. This version of the GREET model reports that for Gasoline and Diesel, approximately 19% of GHG emissions are upstream emissions (scope 3) and 81% are tailpipe emissions (scope 1). For this analysis, it is assumed that energy is used in these same proportions, and therefore the energy use reported by SiteWise is split between scope 3 and scope 1 in these ratios.

GSR Team Calculations to Split GHG Results from SiteWise into "Direct" and "Indirect"
Alternative 4 (Baseline)

phase	Reported by SiteWise		Assigned by GSR Team from SiteWise Output			Total Calculated by GSR Team
			Scope 1 (direct)	Scope 2 (indirect)	Scope 3 (indirect)	
	activity	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	
P&T System O&M – Uses “Remedial Investigation” tab	Consumables	194.44	0.00	0.00	194.44	194.44
	Transportation-Personnel	13.15	0.00	0.00	13.15	13.15
	Transportation-Equipment	13.74	0.00	0.00	13.74	13.74
	Equipment Use and Misc	704.26	0.00	704.26	0.00	704.26
	Residual Handling	0.00	0.00	0.00	0.00	0.00
	Sub-Total	925.59	0.00	704.26	221.33	925.59
Remedy Construction and Well Installation – Uses “Remedial Action Construction” tab	Consumables	122.35	0.00	0.00	122.35	122.35
	Transportation-Personnel	5.61	0.00	0.00	5.61	5.61
	Transportation-Equipment	5.40	0.00	0.00	5.40	5.40
	Equipment Use and Misc	34.37	27.84	0.00	6.53	34.37
	Residual Handling	0.00	0.00	0.00	0.00	0.00
	Sub-Total	167.73	27.84	0.00	139.89	167.73
Bioremediation (Including Studies and Testing) – Uses “Remedial Action Operations” tab	Consumables	2495.14	0.00	0.00	2495.14	2495.14
	Transportation-Personnel	11.63	0.00	0.00	11.63	11.63
	Transportation-Equipment	1033.20	0.00	0.00	1033.20	1033.20
	Equipment Use and Misc	487.39	4.56	481.77	1.06	487.39
	Residual Handling	2.47	0.00	0.00	2.47	2.47
	Sub-Total	4029.83	4.56	481.77	3543.50	4029.83
Monitoring and 5-Year Reviews – Uses “Longterm Monitoring” tab	Consumables	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	23.41	0.00	0.00	23.41	23.41
	Transportation-Equipment	45.47	0.00	0.00	45.47	45.47
	Equipment Use and Misc	0.00	0.00	0.00	0.00	0.00
	Residual Handling	0.00	0.00	0.00	0.00	0.00
	Sub-Total	68.89	0.00	0.00	68.89	68.89
Total		5192.04	32.40	1186.03	3973.60	5192.04

Note: CO2e reported by SiteWise Version 2.0 for electricity use is all associated with generation of the electricity (“Indirect Scope 2”). SiteWise Version 2.0 use fuel emission factors from U.S. Department of Energy, Argonne National Laboratory, Transportation Technology R&D Center, GREET 1.8d.1, Fuel-Cycle model, 2010. This version of the GREET model reports that for gasoline and diesel, approximately 19% of GHG emissions are upstream emissions (Scope 3) and 81% are tailpipe emissions (Scope 1). For this analysis, the GHG emissions reported by SiteWise are split between Scope 3 and Scope 1 in these ratios.

Appendix C

Supporting Information and/or Calculations for Footprinting Variations of Alternative 4

Appendix C-1

Variation 1 - Initial P&T and In-Situ Bio at Waste Lagoon for 3 Years Instead of 5 Years

Appendix C-1
Assumptions for SiteWise Input and Other Calculations
Umatilla Chemical Depot Pilot GSR Evaluation:

Variation 1:
Initial P&T and In-Situ Bio at Waste Lagoon for 3 Years Instead of 5 Years

SiteWise "RA_Variation 1_NoFR_1" Directory

Alternative 4 in the Draft Final FFS was costed (and footprinted in Appendix B) assuming an enhanced version of the current pump and treat system coupled with bioremediation at the waste lagoon for an initial period of 5 years, with full-scale bioremediation thereafter for 10 years. The variation described here is based on the Project Team's belief that the transition from the initial period of expanded P&T with limited bio to a system with no P&T and full-scale bio could occur after only 3 years (rather than the full 5 years used for cost estimating purposes and footprinted in Appendix B of this report), based on groundwater modeling of the planned remedial actions. For the purposes of costing and footprinting, this alternative is assumed to involve the following components:

- Installation of 2 new extraction wells at the beginning of the **13-year** period
- Two injection well tests for in-situ bio (each including installation of a new injection well)
- Continuous P&T with GAC treatment for **3 years** using 2 extraction wells, with an additional 3 extraction wells operated periodically
- Injecting corn syrup (8,150 gallons per event) through the existing infiltration gallery at the waste lagoon (the original source area) for 7 days, 3 times per year for **3 years**
- 2 extraction wells near the waste lagoon (EW-1 and EW-3) will operate during the 7-day injection period during the first **3 years** (this is the water that will be used for the injections)
- The transition to full-scale bioremediation is assumed to occur after **3 years**
- 4 new injection wells will be installed for the initial 2 yr bio period after the first **3 year** period is completed; these wells will be utilized as needed during the entire 10 year full-scale bio period
- An estimated 4 additional injection wells may subsequently be installed for the following 8 yr bio period to better target areas of high contamination, and are assumed for the GSR evaluation
- 1 existing extraction well will be used as an injection well, and 3 existing extraction wells will be used to encourage distribution of injected substrate during this 10 year period of full-scale bio
- 3 treatment events per year for the first 2 years of full-scale bio, using 262,700 gallons of corn syrup per event. Events will last 30 days, with the system at rest for the following 3 months
- It is assumed that injections will continue at 25% of the original substrate mass 2 times per year for the following 4 years then 1 time per year for an additional 4 years
- O&M and monitoring were costed for a total of **13 years**; actual duration of remedial action, O&M and monitoring would be subject to performance evaluation based on measured site data

Note that for the purposes of SiteWise input, it is assumed that transitioning from the initial phase to full-scale bio 2 years earlier will lead to a 2 year decrease in overall remedy duration from the baseline (i.e. full-scale bio will still last for 10 years), for a total remedy duration of 13 years. For this variation on Alternative 4, SiteWise inputs are based on the SiteWise inputs for the Alternative 4 Baseline (included in Appendix B of this report), but changes are made to some quantities to account for only 3 years of the initial enhanced P&T system with limited bio. Any changes to the scope of work and SiteWise input notes are indicated in bold.

The notes pertaining to SiteWise input are organized by the following tabs of the SiteWise input sheet:

- P&T System O&M (First **3 years**)– *Uses "Remedial Investigation" tab of the SiteWise input sheet* (includes labor for the limited bio injections at waste lagoon during that period because it is linked with the system O&M, but the materials such as corn syrup for the bio are included in the "Remedial Action Operations" tab of the SiteWise input sheet)
- Remedy Construction and Well Installation – *Uses "Remedial Action Construction" tab of SiteWise input sheet*
- Bioremediation (Including Studies and Testing) – *Uses "Remedial Action Operations" tab of SiteWise input sheet* (does not include operator labor for the limited bio in the first **3 years**, which is included in the "Remedial Investigation" tab of the SiteWise input sheet
- Monitoring and 5-Year Reviews – *Uses "Longterm Monitoring" tab of SiteWise input sheet*

For each section of SiteWise, all the sections are listed, with pertinent information added only for those sections of the input sheet where data were added.

It should be noted that electricity use entered into SiteWise is based on various items in the RACER Assembly Level Data Report (i.e., Appendix C of the Draft Final FFS) described as "Electrical Charge", each of which lists a number of kWh used.

In some cases, small quantities of materials (such as copper wire, PVC well plugs, bentonite seal on wells, etc.) were not included in SiteWise input because the footprint of these items relative to the other materials used would be expected to be extremely minimal.

Other calculations done outside of SiteWise are then presented. These include the following:

- % of total energy from renewable resources
- Hazardous air pollutants
- Refined material use
- Unrefined material use
- Tons of non-hazardous waste
- Tons of hazardous waste
- % of Potential Waste Recycled
- Risks to on-site workers and from transportation
- Heavy truck trips through residential areas

Additional tables are attached which show how SiteWise outputs were split into "direct" and "indirect" energy use and greenhouse gas emissions. For definitions of direct and indirect energy use and emissions, please refer to section 2.2.2 of the evaluation report.

For cost calculations, The capital costs (no discounting) and annual costs (no discounting) are the same as the baseline alternative, except the capital and annual costs for "years 3 and 4" (which represent the 4th and 5th years of system operation) are eliminated, and the subsequent 10 years of annual costs are moved up two years. Capital costs for the substrate and transportation of the substrate, which are treated as capital costs in year 0 in the RACER analysis performed by the Project Team, are reduced by 40% versus the baseline (note this represents just a portion of the overall capital costs in year 0). Also, the capital costs after the initial two years are moved up by two years. In addition, the same assumption regarding future costs being incurred 83.263% into the year that was used in the baseline alternative is also applied here, so the two scenarios can be compared. A summary cost sheet developed by the GSR Team for the 15-year period (which occurs across portions of 16 fiscal years), based on the RACER data, is attached to this Appendix. Information regarding the cost calculations is as follows:

- The reduction in capital costs for Year 0 are estimated as 40% of the cost of substrate and transportation of the substrate for the in-situ bio at the waste lagoon in the baseline. The cost of the substrate and related transportation is approximated to represent 85% of the in-situ biodegradation "RAC_Remedial_Action_In Situ_5 years" item in the RACER cost summary provided in 'Cost Summary_Alt 4_7-31-11.xlsx' provided by Project Team.

- The annual operating costs vary from year to year but are generally on the order of $250,000 to $680,000 per year

- The sum of capital and annual costs, non-discounted, is $19.69M, which matches the value for non-discounted cots reported in the Draft Final FFS

- To determine net present value (NPV), a 7.0 percent discount rate is applied to future costs, which is consistent with the discount rate applied in the Draft Final FFS. NPV is calculated by discounting future costs to present-day dollars using the following equation:

$$PV = \frac{FV}{(1+i)^n} = C \times FV$$

  PV is the present value
  FV is the value in year "n" (i.e., future value)
  i is the discount rate
  C is the discount factor, which equals $1/(1+i)^n$

- The NPV calculated by the GSR Team is 14.2M (see attached cost spreadsheet)

Variation 1 – P&T System O&M

Scope of Work

The following components of the Assembly Level Data Report included in the Draft Final FFS Appendix C are considered for footprinting the P&T system O&M:

P&T System O&M (initial phase, **3 years**)

Note: The quantities listed in the Draft Final FFS for these items are annual. For footprinting, the quantities are multiplied by **3** to account for the **3 years** of O&M.

Overnight delivery service, 21 to 50 lb packages .... **3***420 LB
Modular liquid-phase activated carbon, Dual Bed, 2 - 10' Diameter, 350 GPM Series, 700 G ...... **3***0.43 EA
Remove Carbon from Vessels, 10,000 - 20,000 Lb Minimum, Transport & Reactivate .... **3***42867 LB

- Assume used GAC sent to Red Bluff, CA (based on information from Project Team during Step 5 call), ~520 miles one way, once per year

Treatment System Operator..1544 HR

- For travel of the system operator and field technicians, Leanna Woods Poon indicated via email that for this **3 year** period, 2 people (mobilizing from Seattle) would be working for 10 days 3 times per year, plus an additional 10 days per month for one person (assumed to be the local system operator). The Project Team indicated on Step 5 call that system operator lives 20 miles from site. This description provided by the Project Team will be used to estimate number and length of trips (rather than the number of hours provided by RACER).

Electrical Charge .... **3***19201 KWH
Electrical Charge .... **3***16321 KWH
Electrical Charge .... **3***4801 KWH
Electrical Charge .... **3***162515 KWH
Electrical Charge .... **3***79534 KWH
Electrical Charge .... **3***36001 KWH

Note that if a field technician is listed in the FFS but no vehicle mileage charge is included it is assumed that the field technician will be on-site for other purposes, and the required travel to and from the site is not included in the footprinting for this alternative.

Variation 1 – P&T System O&M

Input into "Remedial Investigation" tab of SiteWise Input Sheet.xls

- Baseline Information
  - Remedial Investigation Cost
    - Total remedial investigation cost ($) – leave blank in SiteWise

- Material Production
  - Well Materials
  - Treatment Chemicals & Materials
  - Treatment Media
    - Treatment 1 – GAC. 42,867 lbs per year * **3 years** = **128,601 lbs** total. Select regenerated GAC.
  - Construction Materials
  - Well Decommissioning
  - Bulk Material Quantities

- Transportation
  - Personnel Transportation – Road
    - Trip 1 – Additional field technicians for bio injections during first **3 years**. Mobilization from Seattle. Assume car, gasoline. 500 miles round trip. 3 trips per year for **3 years** = **9 trips** with 2 travelers.
    - Trip 2 – Additional field technicians for bio injections during first **3 years**. Trips from local hotel to site (assume 20 miles round trip). Assume car, gasoline. 20 miles round trip, 10 trips 3 times per year for **3 years** = **90 trips** total with 2 travelers.
    - Trip 3 – Treatment system operator. Assume car, gasoline. 40 miles round trip, 10 trips per month * 12 months per year for **3 years** = **360 trips** total with one traveler.
  - Personnel Transportation – Air
  - Personnel Transportation – Rail
  - Equipment Transportation – Road
    - Trip 1 – GAC transport (delivery off-site for regeneration and replacement delivered to the site). Assume diesel, 1040 miles round trip * 1 trip per year * **3 years** (**3120 miles** total), with a transport weight of 42,867 lbs (42,867/2000 = 21.4335 tons).
  - Equipment Transportation – Air
    - Trip 1 – Overnight delivery service, 21 to 50 lb packages (assumed to be samples sent to lab). Assume one 35 lb package sent 1800 miles one way (to ERDC in Vicksburg, MS, which has been used in the past at this site) each month for **3 years**. 1800 miles * 12 months per year * **3 years** (**64800 miles** total), with a transport weight of 35 lbs (35/2000 = 0.0175 tons).
    - Trip 2 – Assumed empty coolers sent to site. Assume one 10 lb package sent 1800 miles one way each month for **3 years**. 1800 miles * 12 months per year * **3 years** (**64800 miles** total), with a transport weight of 10 lbs (10/2000 = 0.005 tons).
  - Equipment Transportation – Rail
  - Equipment Transportation – Water

Variation 1 – P&T System O&M

- Equipment Use
  - Earthwork
  - Drilling
  - Trenching
  - Pump Operation (Electricity Region of "NWPP" is specified on "Site Info" tab of SiteWise)
    - Pump 1 – Used to represent electrical charge for P&T system O&M. Select "Method 1" to directly input electricity use in kWh. **3***19201 = **57603 kWh**.
    - Pump 2 – Used to represent electrical charge for P&T system O&M. Select "Method 1" to directly input electricity use in kWh. **3***16321 = **48963 kWh**.
    - Pump 3 – Used to represent electrical charge for P&T system O&M. Select "Method 1" to directly input electricity use in kWh. **3***4801 = **14403 kWh**.
    - Pump 4 – Used to represent electrical charge for P&T system O&M. Select "Method 1" to directly input electricity use in kWh. **3***162515 = **487545 kWh**.
    - Pump 5 – Used to represent electrical charge for P&T system O&M. Select "Method 1" to directly input electricity use in kWh. **3***79534 = **238602 kWh**.
    - Pump 6 – Used to represent electrical charge for P&T system O&M. Select "Method 1" to directly input electricity use in kWh. **3***36001 = **108003 kWh**.
  - Diesel and Gasoline Pumps
  - Blower, Compressor, Mixer, and Other Equipment
  - Generators
  - Agricultural Equipment
  - Capping Equipment
  - Mixing Equipment
  - Internal Combustion Engines
  - Other Fueled Equipment
  - Operator Labor
  - Laboratory Analysis
  - Other Known Onsite Activities

- Residual Handling
  - Residue Disposal/Recycling
  - Landfill Operations
  - Thermal/Catalytic Oxidizers

- Resource Consumption
  - Water Consumption
  - Onsite Land and Water Resource Consumption

Once SiteWise input is complete, go to "SiteWise_Input Sheet" for overall project and enter information (including Alternative File Name "Variation 1"). Then go to "Generate Alternative" tab and click button labeled "Click to generate alternative using previously entered alternative name". Copies of the input and output summary sheets for this alternative are now located in the directory titled "RA_Variation 1_NoFR_1". To store the "Remedial Investigation.xls" calculation sheet showing detailed calculations, open it in the overall SiteWise project directory when the appropriate input sheet is open, then do a "save as" to put it in the directory for this alternative using a name that

indicates “will not update”. Then open that file and do “data->edit links” and break the links. If the input sheet for this alternative ever changes, then this calculation sheet needs to be re-saved.

To edit input parameters for this alternative, you must go back to the ORIGINAL SiteWise input sheet and import this alternative using the “Do you want to reload a previously saved remedial alternative in the SiteWise input sheet?” field on the “Site Info” tab. After making necessary changes to the input sheet, re-export the alternative by going to the “Generate Alternative” tab and clicking the button labeled “Click to replace an existing alternative with the same name”. Update saved calculation sheets as described above.

Variation 1 – Remedy Construction and Well Installation

Scope of Work

The following components of the RACER Assembly Level Data Report included in the Draft Final FFS Appendix C are considered for footprinting the remedy construction and well installation:

Extraction Well Installation (2 New EWs)/Associated Piping and Trenching

Mobilize/Demobilize Drilling Rig & Crew .... 1 LS
Field Technician .... 26 HR

- Assume from field technician hours that there are 3 approximately 8-hr days for well installation

12" PVC, Schedule 80, Well Casing .... 220 LF
12" PVC, Schedule 80, Well Screen .... 40 LF
Air Rotary, 16" Dia Borehole (Unconsolidated), 100 ft < Depth <= 500 ft .... 248 LF
12" Well, Portland Cement Grout .... 106 LF

Notes: Trenching dimensions described as 3000' x 2' x 3' and 200' x 2' x 3'
100% of excavated material will be used as backfill

Cat 215, 1.0 CY, Soil, Shallow, Trenching, Excludes Sheeting, Excludes Dewatering .... 666.67 BCY

- Assume 85 HP, equipment weight = 36155.8 lbs (http://www.ritchiespecs.com/specification?type=&category=Hydraulic+Excavator&make=Caterpillar&model=215&modelid=92851)

On-Site Backfill for Large Excavations, Includes Compaction .... 766.67 ECY
Backfill with Crushed Stone .... 111.11 CY
Compaction, subgrade, 18" wide, 8" lifts, walk behind, vibrating plate .... 111.11 ECY
6" PVC, Schedule 80, Connection Piping .... 3000 LF

Cat 215, 1.0 CY, Soil, Shallow, Trenching, Excludes Sheeting, Excludes Dewatering .... 44.44 BCY
On-Site Backfill for Large Excavations, Includes Compaction .... 51.11 ECY
6" Unreinforced Slab on Grade .... 400 SF
6" Stainless Steel Piping, Schedule 10, Type 316, Excludes Joints, Hangers .... 200 LF

Injection Well Installation/Associated Piping and Trenching

Note: In the Draft Final FFS, the following quantities are included as two separate (but identical) listings, one for the initial 2 year period of bioremediation and another for the following 8 year period of bioremediation. For the purpose of SiteWise input, they have been combined. Note that there will still be 2 separate mobilizations for drilling.

6" Stainless Steel, Well Casing .... 2*440 LF
6" Stainless Steel, Well Screen .... 2*80 LF
Air Rotary, 10" Dia Borehole (Unconsolidated), 100 ft < Depth <= 500 ft .... 2*520 LF
Mobilization/Demobilization, Drill Equipment or Trencher, Crew .... 2*1 EA
6" Screen, Filter Pack .... 2*92 LF
Surface Pad, Concrete, 4' x 4' x 4" .... 2*4 EA
6" Well, Portland Cement Grout .... 2*428 LF
3" Carbon Steel Piping .... 2*40 LF
4" High-density Polyethylene, Transfer Pipe .... 2*800 LF

Variation 1 – Remedy Construction and Well Installation

Cat 215, 1.0 CY, Soil, Shallow, Trenching, Excludes Sheeting, Excludes Dewatering ....1777.78 BCY
On-Site Backfill for Large Excavations, Includes Compaction .... 2044.44 ECY
Backfill with Crushed Stone .... 296.30 CY
Compaction, subgrade, 18" wide, 8" lifts, walk behind, vibrating plate .... 296.30 ECY

Assume drilling crew, piping, and other materials coming from Tacoma (approximate 270 miles one way) based on information provided by the Project Team during Step 5 call.

Note that if a field technician is listed in the FFS but no vehicle mileage charge is included it is assumed that the field technician will be on-site for other purposes, and the required travel to and from the site is not included in the footprinting for this alternative.

Variation 1 – Remedy Construction and Well Installation

<u>Input into "Remedial Action Construction" tab of SiteWise Input Sheet.xls</u>

- Baseline Information
    - Remedial Action Construction Cost
        - Total remedial action construction cost ($) – leave blank in SiteWise

- Material Production
    - Well Materials
        - Well Type 1 – Extraction wells. 2 wells, 110 ft casing + 20 ft screen = 130 ft depth for each well. Schedule 80 PVC, 12" diameter.
        - Well Type 2 – Injection wells. 8 wells, 110 ft casing + 20 ft screen = 130 ft depth for each well. Stainless steel (assume Sch 40S), 6" diameter.
        - Well Type 3 – Used for input of PVC connecting pipe for extraction wells. 1 well, 3000 ft, Sch 80 PVC, 6" diameter.
        - Well Type 4 – Used for input of stainless steel piping for extraction wells. 1 well, 200 ft, Sch 10S stainless steel, 6" diameter.
        - Well Type 5 – Used for input of carbon steel piping for injection wells. 2 wells, 40 ft, assume Sch 40 Steel to represent carbon steel, 3" diameter.
        - Well Type 6 – Used for input of high-density polyethylene transfer pipe for injection wells. 2 wells, 800 ft, assume Sch 40 HDPE pipe, 4" diameter.
    - Treatment Chemicals & Materials
    - Treatment Media
    - Construction Materials
        - Material 1 – Used for injection well filter pack. 10" borehole and 6" screen, 23 ft length per well. Use gravel for filter material. Area of material = $\pi 5^2 - \pi 3^2$ = 50.27 square inches = .35 square feet. Depth of material is 184 (total for all 8 wells).
        - Material 2 – Used for injection well concrete surface pads. Select general concrete. Each pad is 4' x 4' x 4', one pad each for 8 wells = 512 cubic feet total for all wells. Enter 16 cubic feet (4' x 4') for area and 32 feet (4' x 8) for depth.
        - Material 3 – Portland cement grout listed under extraction well installation. 16" borehole and 12" well casing, 53 ft length per well. Select typical cement. Area of material = $\pi 8^2 - \pi 6^2$ = 87.96 square inches = .61 square feet. Depth of material is 106 (total for both wells).
        - Material 4 – Portland cement grout listed under injection well installation. 10" borehole and 6" well casing, 107 ft length per well. Area of material = $\pi 5^2 - \pi 3^2$ = 50.27 square inches = .35 square feet. Depth of material is 856 (total for all 8 wells).
        - Material 5 – Unreinforced Slab on Grade. Use general concrete, 400 square ft, 0.5 ft deep.
        - Material 6 – Crush stone for backfill. Use gravel, 111 cubic yards for EWs and 296 cubic yards for IWs = 407 cubic yds. Total = 10989 cubic ft. Assign as 10989 square ft with 1 foot depth.
    - Well Decommissioning
    - Bulk Material Quantities

- Transportation
    - Personnel Transportation – Road

3 separate drilling events – Assume from FFS Appendix C: installation of 2 extraction wells in 3 days; installation of 4 injection wells in one week for 2 yr bio; and installation of additional 4 injection wells in one week for 8 yr bio (occurring several years apart, so 3 distinct mobilizations). Trips are consolidated here to fit within 6 columns for SiteWise input.

  - Trip 1 – Light truck supporting drill rig. Light truck, gasoline. 540 miles round trip from Tacoma to site. 3 round trips with one passenger.
  - Trip 2 – Light truck supporting drill rig. Light truck, gasoline. Assume 20 miles round trip from local hotel, one round trip per day for the 3+5+5 = 13 days of well installation with 3 passengers.
  - Trip 3 – Round-trip for drill rig. Heavy duty, diesel. 540 miles round trip from Tacoma to site. 3 round trips with one passenger.
  - Trip 4 – Round-trip for heavy duty truck supporting drill rig. Heavy duty, diesel. 540 miles round trip from Tacoma to site. 3 round trips with one passenger.

- Personnel Transportation – Air
- Personnel Transportation – Rail
- Equipment Transportation – Road
  - Trip 1 – Transport Cat 215 excavator to site. Diesel. Assume 60 miles round trip (30 miles each way) dropping off and picking up from site * 3 trenching events (separate events for extraction well installation, 2yr bio injection well installation, and 8 yr bio injection well installation) (empty return trips included below). Assume weight = 36155.8 lbs/2000 = 18.1 tons.
  - Trip 2 – Transport of extraction well casing, associated materials, and piping to site. Diesel. 270 miles one way from Tacoma. Use remedial action construction output file to determine pipe and material weight. (4520 lbs + 16830 lbs + 1868 lbs + (2757.4 kg + 13427.9 kg)*2.2)/2000 = 29.41 tons.
  - Trip 3 – Transport of injection well casing, associated materials, and piping to site. Diesel. 270 miles one way from Tacoma * 2 for separate deliveries for 2yr and 8yr bio. Use remedial action construction output file to determine pipe weight, which will be half of the combined weights for “well type 2”, “well type 5”, and “well type 6” because SiteWise input for piping was combined for 2yr and 8yr bio well installation events, and add materials weights, which will also be half of the combined weights for materials 1, 2, and 4 because of combined input. (19777 lbs + 607 lbs + 2638 lbs + (3067.3kg + 34375.3kg + 12776.5kg) * 2.2)/2/2000 = 33.38 tons per delivery.
  - Trip 4 – Transport of crushed stone. Use remedial action construction output file to determine weight. 576 tons. Assume 60 miles round trip (30 miles each way). Since the weight limit for an on-road truck load in SiteWise is 40 tons, the total distance traveled must be increased to account for the additional trucks needed to transport material (assume full loads). The 30 mile trip was multiplied by 576/40 (or 14 rips) for a total of 420 mile traveled with 40 ton loads.
  - Trip 5 – Empty return trips for Trips 1 – 3 above. 30*3 + 270 + 540 + 30*14 = 1320 miles total. Enter 0 tons.
- Equipment Transportation – Air
- Equipment Transportation – Rail

- Equipment Transportation – Water

- Equipment Use
  - Earthwork
    - Equipment 1 – Cat 215 excavator, extraction well trenching. Select excavator, diesel. 666.67 + 44.44 cubic yards (combined 2 entries) = 711.11 cubic yards to be moved.
    - Equipment 2 – Cat 215 excavator, extraction well backfill. Select excavator, diesel. 766.67 + 51.11 + 111.11 (combined 3 entries) = 928.89 cubic yards to be backfilled.
    - Equipment 3 – Cat 215 excavator, injection well trenching. Select excavator, diesel. 1777.78 * 2 = 3556 cubic yards to be moved.
    - Equipment 4 – Cat 215 excavator, injection well backfill. Select excavator, diesel. (2044.44 + 296.30) * 2 = 4681 cubic yards to be backfilled.
  - Drilling
    - Event 1 – Extraction well installation. 2 wells, air rotary drilling, assume 12 hours per well (from field technician hours), diesel fuel.
    - Event 2 – Injection well installation (2 yr bio). 4 wells, air rotary drilling, assume 10 hours per well, diesel.
    - Event 3 – Injection well installation (8 yr bio). 4 wells, air rotary drilling, assume 10 hours per well, diesel.
  - Trenching
    - Trencher 1 – Used to represent vibrating plate compactor for extraction well trenching. Select gasoline, 3 to 6 HP, assume 2 hours of operation.
    - Trencher 2 – Used to represent vibrating plate compactor for extraction well trenching. Select gasoline, 3 to 6 HP, assume 4 hours of operation.
  - Pump Operation
  - Diesel and Gasoline Pumps
  - Blower, Compressor, Mixer, and Other Equipment
  - Generators
  - Agricultural Equipment
  - Capping Equipment
  - Mixing Equipment
  - Internal Combustion Engines
  - Other Fueled Equipment
  - Operator Labor
  - Laboratory Analysis
  - Other Known Onsite Activities

- Residual Handling
  - Residue Disposal/Recycling
  - Landfill Operations
  - Thermal/Catalytic Oxidizers

- Resource Consumption
  - Water Consumption
  - Onsite Land and Water Resource Consumption

Variation 1 – Remedy Construction and Well Installation

Once SiteWise input is complete, go to "SiteWise_Input Sheet" for overall project and enter information (including Alternative File Name "Variation 1"). Then go to "Generate Alternative" tab and click button labeled "Click to generate alternative using previously entered alternative name". Copies of the input and output summary sheets for this alternative are now located in the directory titled "RA_Variation 1 _NoFR_1". To store the "Remedial Action Construction.xls" calculation sheet showing detailed calculations, open it in the overall SiteWise project directory when the appropriate input sheet is open, then do a "save as" to put it in the directory for this alternative using a name that indicates "will not update". Then open that file and do "data->edit links" and break the links. If the input sheet for this alternative ever changes, then this calculation sheet needs to be re-saved.

To edit input parameters for this alternative, you must go back to the ORIGINAL SiteWise input sheet and import this alternative using the "Do you want to reload a previously saved remedial alternative in the SiteWise input sheet?" field on the "Site Info" tab. After making necessary changes to the input sheet, re-export the alternative by going to the "Generate Alternative" tab and clicking the button labeled "Click to replace an existing alternative with the same name". Update saved calculation sheets as described above.

Variation 1 – Bioremediation (Including Studies and Testing)

Scope of Work

The following components of the RACER Assembly Level Data Report included in the Draft Final FFS Appendix C are considered for footprinting the bioremediation (including studies and testing, but not labor for limited Bio in first **3 yrs** which is lumped with P&T O&M):

LAPP-2 Study

Rail and Tanker Truck Transportation for Corn Syrup ....944 CWT

- Assume 2400 miles of rail transport from supplier in Tennessee to Seattle, and 250 miles of truck transport from Seattle to Umatilla. 944 CWT = 94,400 lbs.

Food Grade Starch Bioremediation Substrate .... 94400 LB

- SiteWise does not have conversion factors for corn syrup, so vegetable oil will be used as a surrogate throughout, since it is assumed to have a similar environmental footprint.

Injection Well Tests (2)

Note: In the Draft Final FFS, the following quantities are included as two separate (but identical) listings, one for each injection well test. For footprinting purposes, these separate entries have been combined as listed below. Assuming they will be installed at the same time, only one mobilization for drilling will be footprinted.

Rail and Tanker Truck Transportation ....2*1531 CWT
Non Haz Drummed Site Waste - Load, Transp, & Landfill Disp (55-Gal Drums) ....2*50 EA
6" Stainless Steel, Well Casing ....2*110 LF
6" Stainless Steel, Well Screen ....2*20 LF
Air Rotary, 10" Dia Borehole (Unconsolidated), 100 ft < Depth <= 500 ft ....2*130 LF
Mobilization/Demobilization, Drill Equipment or Trencher, Crew ....1 EA
6" Screen, Filter Pack ....2*23 LF
Surface Pad, Concrete, 4' x 4' x 4" ....2*1 EA
6" Well, Portland Cement Grout ....2*107 LF
3" Carbon Steel Piping ....2*10 LF
6" High-density Polyethylene, Transfer Pipe ....2*200 LF
Food Grade Starch Bioremediation Substrate .... 2*153122 LB

Lagoon Injections (total for initial **3 years** of injections during continued P&T)

Rail and Tanker Truck Transportation .... **3/5***14425 CWT
Non Haz Drummed Site Waste - Load, Transp, & Landfill Disp (55-Gal Drums) .... **3/5***60 EA
Food Grade Starch Bioremediation Substrate ....**3/5***1442550 LB

Plume Injections (total for first 2 years of full-scale bio)

Rail and Tanker Truck Transportation ....97999 CWT
Non Haz Drummed Site Waste - Load, Transp, & Landfill Disp (55-Gal Drums) ....180 EA
Food Grade Starch Bioremediation Substrate .... 9799968 LB

Variation 1 – Bioremediation (Including Studies and Testing)

<u>Plume Injections (total for subsequent 8 years of full-scale bio)</u>

Rail and Tanker Truck Transportation ....48999 CWT
Non Haz Drummed Site Waste - Load, Transp, & Landfill Disp (55-Gal Drums) ....360 EA
Food Grade Starch Bioremediation Substrate .... 4899984 LB

<u>Well Network O&M for 10 Years</u>
Note: The quantities listed in the Draft Final FFS are annual for the entire 10 years of full-scale bio, so each quantity is multiplied by 10 to account for the full 10 years of bio.

Treatment System Operator ....10*1015 HR

- Leanna Woods Poon indicated via email that for the 10 years of full-scale bio, 2 people (mobilizing from Seattle) would be working for 33 days 3 times per year for the first 2 years, then 2 people (mobilizing from Seattle) would be working for 33 days 2 times per year for the next 4 years, then 2 people (mobilizing from Seattle) would be working for 33 days 1 time per year for the next 4 years, plus an additional 1 day per month for one person for the entire 10 year period (assumed to be the local system operator). The Project Team indicated on Step 5 call that system operator lives 20 miles from site. This description provided by the project team will be used to estimate number and length of trips (rather than the number of hours provided by RACER).

Electrical Charge .... 10*6681 KWH
Electrical Charge .... 10*61496 KWH
Electrical Charge .... 10*18449 KWH
Electrical Charge .... 10*22269 KWH

Note that if a field technician is listed in the FFS but no vehicle mileage charge is included it is assumed that the field technician will be on-site for other purposes, and the required travel to and from the site is not included in the footprinting for this alternative.

Variation 1 – Bioremediation (Including Studies and Testing)

Input into "Remedial Action Operations" tab of SiteWise Input Sheet.xls

- Baseline Information
  - Remedial Action Operations Cost and Duration
    - Total remedial action operations cost ($) – leave blank in SiteWise
    - Duration of remedial action operations (unit time) – 1 yr for this GSR evaluation because we have multiplied input items by number of years as part of the input

- Material Production
  - Well Materials
    - Well Type 1 – Well casing/screen for injection well tests. 2 wells, 110 ft casing + 20 ft screen = 130 ft depth for each well. Stainless steel (assume Sch 40S), 6" diameter.
    - Well Type 2 – Used for input of carbon steel piping for injection well tests. 2 wells, 10 ft, assume Sch 40 Steel to represent carbon steel, 3" diameter.
    - Well Type 3 – Used for input of high-density polyethylene transfer pipe for injection well tests. 2 wells, 200 ft, assume Sch 40 HDPE pipe, 6" diameter.
  - Treatment Chemicals & Materials
  - Treatment Media
  - Construction Materials
    - Material 1 – Used for test injection well filter pack. 10" borehole and 6" screen, 23 ft length per well. Use gravel for filter material. Area of material = $\pi 5^2 - \pi\ 3^2$ = 50.27 square inches = .35 square feet. Depth of material is 46 (total for both wells).
    - Material 2 – Used for test injection well concrete surface pads. Select general concrete. Each pad is 4' x 4' x 4', one pad each for 2 wells = 128 cubic feet total. Enter 16 cubic feet (4' x 4') for area and 8 feet (4' x 2) for depth.
    - Material 3 – Portland cement grout listed under injection well installation. 10" borehole and 6" well casing, 107 ft length per well. Area of material = $\pi 5^2 - \pi\ 3^2$ = 50.27 square inches = .35 square feet. Depth of material is 214 (total for both wells).
  - Well Decommissioning
  - Bulk Material Quantities
    - Material 1 – Food grade starch bioremediation substrate (corn syrup) for LAPP-2 Study. Use vegetable oil to represent corn syrup. 94,400 lbs.
    - Material 2 – Corn syrup for injection well tests. Use vegetable oil to represent corn syrup. 153,122 lbs * 2 tests = 306,244 lbs.
    - Material 3 – Corn syrup for lagoon injections (initial phase, **3 year** total). Use vegetable oil to represent corn syrup. 1,442,550 lbs * **3/5** = **865,530 lbs**.
    - Material 4 – Corn syrup for plume injections (full-scale bio, first 2 year total). Use vegetable oil to represent corn syrup. 9,799,968 lbs.
    - Material 5 – Corn syrup for plume injections (full-scale bio, next 8 year total). Use vegetable oil to represent corn syrup. 4,899,984 lbs.
- Transportation
  - Personnel Transportation – Road
    - Trip 1 – Light truck supporting drill rig. Light truck, gasoline. 540 miles round trip from Tacoma to site. 1 round trip with one passenger.

    - Trip 2 – Light truck supporting drill rig. Light truck, gasoline. Assume 20 miles round trip from local hotel, one round trip per day for the 2 days of well installation with 3 passengers.
    - Trip 3 – Round-trips for drill rig and heavy duty truck supporting drill rig (combined for SiteWise entry). Heavy duty, diesel. 540 miles round trip from Tacoma to site * 2 vehicles = 1080 miles. Enter 1 round trip with 1 passenger.
    - Trip 4 – Additional field technicians for bio injections during 10 years of full-scale bio. Mobilization from Seattle. Assume car, gasoline. 500 miles round trip. 3 trips per year * 2 years + 2 trips per year * 4 years + 1 trip per year * 4 years = 18 trips with 2 travelers.
    - Trip 5 – Additional field technicians for bio injections during 10 years of full-scale bio. Trips from local hotel to site (assume 20 miles round trip). Assume car, gasoline. 20 miles round trip, 33 trips * 3 events per year * 2 years + 33 trips * 2 events per year * 4 years + 33 trips * 1 event per year * 4 years = 594 trips total with 2 travelers.
    - Trip 6 – Treatment system operator. Assume car, gasoline. 40 miles round trip, 1 trip * 12 times per year * 10 years = 120 trips total with one traveler.
  - Personnel Transportation – Air
  - Personnel Transportation – Rail
  - Equipment Transportation – Road
    - Trip 1 – Transport of test injection well casing, associated materials, and piping to site. Diesel. 270 miles one way from Tacoma. Use remedial action operation output file to determine pipe and material weight. (4944 lbs + 152 lbs + 978 lbs + (766.8 kg + 8593.8 kg + 3194.1 kg)*2.2)/2000 = 15.59 tons.
    - Trip 2 – Corn syrup transport from Seattle to Umatilla. 250 miles one way from Seattle. Total mass to be transported over **13 yr** remedy duration is 47.2 tons + 153.1 tons + **432.765 tons** + 4900.0 tons + 2450.0 tons = **7983.065 tons**. Since the weight limit for an on-road truck load in SiteWise is 40 tons, the total distance traveled must be increased to account for the additional trucks needed to transport material (assume full loads). The 250 mile trip was multiplied by **7983.065**/40 (or **199.576625** trips) for a total of **49894.2 miles** traveled with 40 ton loads.
    - Trip 3– Empty return trips. Total empty miles for the trips above are 270 mi + **49894.2 mi** = **50164.2 mi**
  - Equipment Transportation – Air
  - Equipment Transportation – Rail
    - Trip 1 – Corn syrup transport from Tennessee to Seattle (LAPP-2 Study). Assume 2400 miles. 94400 lbs / 2000 = 47.2 tons.
    - Trip 2 – Corn syrup transport from Tennessee to Seattle (Injection Well Tests). Assume 2400 miles. 2*153122 lbs / 2000 = 153.1 tons.
    - Trip 3 – Corn syrup transport from Tennessee to Seattle (Lagoon Injections). Assume 2400 miles. **3/5** * 1442550 lbs / 2000 = **432.765 tons**.
    - Trip 4 – Corn syrup transport from Tennessee to Seattle (Plume Injections, 2yr). Assume 2400 miles. 9799968 lbs / 2000 = 4900.0 tons.
    - Trip 5 – Corn syrup transport from Tennessee to Seattle (Plume Injections, 8yr). Assume 2400 miles. 4899984 lbs / 2000 = 2450.0 tons.
  - Equipment Transportation – Water

Variation 1 – Bioremediation (Including Studies and Testing)

- Equipment Use
  - Earthwork
  - Drilling
    - Event 1 – Test injection well installation. 2 wells, air rotary drilling, assume 10 hours per well, diesel.
  - Trenching
  - Pump Operation (Electricity Region of "NWPP" is specified on "Site Info" tab of SiteWise)
    - Pump 1 – Used to represent electrical charge for Well Network O&M. Select "Method 1" to directly input electricity use in kWh. 10*6681 = 66810 kWh.
    - Pump 2 – Used to represent electrical charge for Well Network O&M. Select "Method 1" to directly input electricity use in kWh. 10*61496 = 614960 kWh.
    - Pump 3 – Used to represent electrical charge for Well Network O&M. Select "Method 1" to directly input electricity use in kWh. 10*18449 = 184490 kWh.
    - Pump 4 – Used to represent electrical charge for Well Network O&M. Select "Method 1" to directly input electricity use in kWh. 10*22269 = 222690 kWh.
  - Diesel and Gasoline Pumps
  - Blower, Compressor, Mixer, and Other Equipment
  - Generators
  - Agricultural Equipment
  - Capping Equipment
  - Mixing Equipment
  - Internal Combustion Engines
  - Other Fueled Equipment
  - Operator Labor
  - Laboratory Analysis
  - Other Known Onsite Activities

- Residual Handling
  - Residue Disposal/Recycling
    - Soil Residue – 55 gallon drum disposal for injection well tests. Assume 55 gallon drums contain mostly purge water and possibly some heavier material. Water is 8.33 lbs per gallon, so assume each drum is ~500 lbs. 500 lbs * 100 drums = 50,000 lbs/2000 = 25 tons transported. Assume diesel, 1 trip, 50 miles 1 way.
    - Residual water – 55 gallon drum disposal for **3 years** of lagoon injections. Assume 55 gallon drums contain mostly purge water and possibly some heavier material. Water is 8.33 lbs per gallon, so assume each drum is ~500 lbs. 500 lbs * **36 drums** = 18,000 lbs/2000 = **9 tons** transported. Assume 1 trip per year to transport waste off-site, which would equate to 3 tons per trip. Assume diesel, **3 trips**, 50 miles 1 way.
    - Material Residue – 55 gallon drum disposal for first 2 years of plume injections. Assume 55 gallon drums contain mostly purge water and possibly some heavier material. Water is 8.33 lbs per gallon, so assume each drum is ~500 lbs. 500 lbs * 180 drums = 90,000 lbs/2000 = 45 tons transported. Assume 1 trip per year to transport waste off-site, which would equate to 22.5 tons per trip. Assume diesel, 2 trips, 50 miles 1 way.
    - Other Residue – 55 gallon drum disposal for next 8 years of plume injections. Assume 55 gallon drums contain mostly purge water and possibly some heavier

material. Water is 8.33 lbs per gallon, so assume each drum is ~500 lbs. 500 lbs * 360 drums = 180,000 lbs/2000 = 90 tons transported. Assume 1 trip per year to transport waste off-site, which would equate to 11.25 tons per trip. Assume diesel, 8 trips, 50 miles 1 way.

        - Other Residue – Empty trips to site for all of the above trips. Enter 0 for weight and diesel for fuel. Sum number of trips from above (1+**3**+2+8 = **14 trips**), 50 miles 1 way.
    - Landfill Operations
    - Thermal/Catalytic Oxidizers

- Resource Consumption
    - Water Consumption
    - Onsite Land and Water Resource Consumption

Once SiteWise input is complete, go to "SiteWise_Input Sheet" for overall project and enter information (including Alternative File Name "Variation 1"). Then go to "Generate Alternative" tab and click button labeled "Click to generate alternative using previously entered alternative name". Copies of the input and output summary sheets for this alternative are now located in the directory titled "RA_Variation 1_NoFR_1". To store the "Remedial Action Operations.xls" calculation sheet showing detailed calculations, open it in the overall SiteWise project directory when the appropriate input sheet is open, then do a "save as" to put it in the directory for this alternative using a name that indicates "will not update". Then open that file and do "data->edit links" and break the links. If the input sheet for this alternative ever changes, then this calculation sheet needs to be re-saved.

To edit input parameters for this alternative, you must go back to the ORIGINAL SiteWise input sheet and import this alternative using the "Do you want to reload a previously saved remedial alternative in the SiteWise input sheet?" field on the "Site Info" tab. After making necessary changes to the input sheet, re-export the alternative by going to the "Generate Alternative" tab and clicking the button labeled "Click to replace an existing alternative with the same name". Update saved calculation sheets as described above.

Variation 1 – Monitoring and 5-Year Reviews

Scope of Work

The following components of the RACER Assembly Level Data Report included in the Draft Final FFS Appendix C are considered for footprinting the monitoring and 5-year reviews:

Single Monitoring Event during RA (2 week event requiring 2 people)

Sample collection, vehicle mileage charge, car or van .... 1300 MI
Overnight delivery service, 51 to 70 lb packages .... 840 LB

- Assume 14 coolers at 60 lbs each (full) are sent 100 miles from site to lab. Assume 14 coolers at 10 lbs each (empty) sent 100 miles from lab to site.

Monitoring for Initial **3 Years** of P&T and bio injections (3 events per year, 2 weeks per event, requiring 2 people)

Note: The quantities listed in the Draft Final FFS are annual. For footprinting, the quantities are multiplied by **3** to account for the **3 years** of monitoring.

Sample collection, vehicle mileage charge, car or van .... **3***3900 MI
Overnight delivery service, 51 to 70 lb packages .... **3***2460 LB

Monitoring for First 2 Years of Full-Scale Bio (3 events per year, 2 weeks per event, requiring 2 people)

Note: The quantities listed in the Draft Final FFS are annual. For footprinting, the quantities are multiplied by 2 to account for the 2 years of monitoring.

Sample collection, vehicle mileage charge, car or van .... 2*3900 MI
Overnight delivery service, 51 to 70 lb packages .... 2*2460 LB

Monitoring for Subsequent 8 Years of Full-Scale Bio (2 events per year, 2 weeks per event, requiring 2 people)

Note: The quantities listed in the Draft Final FFS are annual. For footprinting, the quantities are multiplied by 8 to account for the 8 years of monitoring.

Sample collection, vehicle mileage charge, car or van .... 8*2600 MI
Overnight delivery service, 51 to 70 lb packages .... 8*1680 LB

Five Year Reviews (2 people per site visit, $500 each allotted for plane ticket)

Note: The quantities listed in the Draft Final FFS are for one 5-year review. For footprinting, the quantities are multiplied by 3 to account for the 3 anticipated 5-year reviews during the 15 year period of remedial action.

Sedan, Automobile, Rental .... 3*3 DAY
Airfare .... 3*2 LS

Variation 1 – Monitoring and 5-Year Reviews

Note that if a field technician is listed in the FFS but no vehicle mileage charge is included it is assumed that the field technician will be on-site for other purposes, and the required travel to and from the site is not included in the footprinting for this alternative.

Variation 1 – Monitoring and 5-Year Reviews

<u>Input into "Longterm Monitoring" tab of SiteWise Input Sheet.xls</u>

- Baseline Information
  - Longterm Monitoring Cost and Duration
    - Total remedial action operations cost ($) – leave blank in SiteWise
    - Duration of Longterm Monitoring (unit time) – 1 yr for this GSR evaluation because we have multiplied input items by number of years as part of the input

- Material Production
  - Well Materials
  - Treatment Chemicals & Materials
  - Treatment Media
  - Construction Materials
  - Well Decommissioning
  - Bulk Material Quantities

- Transportation
  - Personnel Transportation – Road
    - Trip 1 – Sample collection during RA. Select SUV (mileage in between car and van), gasoline. 1300 miles, 1 trip, 2 travelers.
    - Trip 2 – Sample collection during initial **3 yr** monitoring. Select SUV (mileage in between car and van), gasoline. 3900 miles, **3 trips**, 2 travelers.
    - Trip 3 – Sample collection during 2 yr bio monitoring. Select SUV (mileage in between car and van), gasoline. 3900 miles, 2 trips, 2 travelers.
    - Trip 4 – Sample collection during 8 yr bio monitoring. Select SUV (mileage in between car and van), gasoline. 2600 miles, 8 trips, 2 travelers.
    - Trip 5 – Five year reviews. Select car, gasoline. Assume 20 miles round trip from local hotel to site, 3 days per site visit * 3 reviews over 15yr remedy period = 9 trips total, 2 travelers.
  - Personnel Transportation – Air
    - Trip 1 – Five year reviews. Assume 500 miles traveled per round trip flight per traveler, 2 travelers, 3 round trip flights.
  - Personnel Transportation – Rail
  - Equipment Transportation – Road
  - Equipment Transportation – Air
    - Trip 1 – Monitoring during RA, overnight delivery service, 51 to 70 lb packages (assumed to be samples sent to lab). Assume 14 coolers, 35 lbs average weight (10 lbs empty and 60 lbs full) each, sent 3600 miles round trip to ERDC, a previously used lab in Vicksburg, MS (assumed). 3600 miles, with a transport weight of 35 lbs * 14 coolers / 2000 = 0.245 tons.
    - Trip 2 – Initial **3 yr** monitoring, overnight delivery service, 51 to 70 lb packages (assumed to be samples sent to lab). Assume 41 coolers per year for **3 years**, 35 lbs average weight (10 lbs empty and 60 lbs full) each, sent 3600 miles round trip. 3600 miles, with a transport weight of 35 lbs * 41 coolers * **3 yrs** / 2000 = **2.1525 tons**.
    - Trip 3 – 2 yr bio monitoring, overnight delivery service, 51 to 70 lb packages (assumed to be samples sent to lab). Assume 41 coolers per year for 2 years, 35 lbs average weight (10 lbs empty and 60 lbs full) each, sent 3600 miles round

trip. 3600 miles, with a transport weight of 35 lbs * 41 coolers * 2 yrs / 2000 = 1.44 tons.
    - Trip 4 – 8 yr bio monitoring, overnight delivery service, 51 to 70 lb packages (assumed to be samples sent to lab). Assume 28 coolers per year for 8 years, 35 lbs average weight (10 lbs empty and 60 lbs full) each, sent 3600 miles round trip. For SiteWise input, assume diesel, 3600 miles, with a transport weight of 35 lbs * 28 coolers * 8 yrs / 2000 = 3.92 tons.
  - Equipment Transportation – Rail
  - Equipment Transportation – Water

- Equipment Use
  - Earthwork
  - Drilling
  - Trenching
  - Pump Operation
  - Diesel and Gasoline Pumps
  - Blower, Compressor, Mixer, and Other Equipment
  - Generators
  - Agricultural Equipment
  - Capping Equipment
  - Mixing Equipment
  - Internal Combustion Engines
  - Other Fueled Equipment
  - Operator Labor
  - Laboratory Analysis
  - Other Known Onsite Activities

- Residual Handling
  - Residue Disposal/Recycling
  - Landfill Operations
  - Thermal/Catalytic Oxidizers

- Resource Consumption
  - Water Consumption
  - Onsite Land and Water Resource Consumption

Once SiteWise input is complete, go to "SiteWise_Input Sheet" for overall project and enter information (including Alternative File Name "Variation 1"). Then go to "Generate Alternative" tab and click button labeled "Click to generate alternative using previously entered alternative name". Copies of the input and output summary sheets for this alternative are now located in the directory titled "RA_Variation 1_NoFR_1". To store the "Longterm Monitoring.xls" calculation sheet showing detailed calculations, open it in the overall SiteWise project directory when the appropriate input sheet is open, then do a "save as" to put it in the directory for this alternative using a name that indicates "will not update". Then open that file and do "data->edit links" and break the links. If the input sheet for this alternative ever changes, then this calculation sheet needs to be re-saved.

Variation 1 – Monitoring and 5-Year Reviews

To edit input parameters for this alternative, you must go back to the ORIGINAL SiteWise input sheet and import this alternative using the "Do you want to reload a previously saved remedial alternative in the SiteWise input sheet?" field on the "Site Info" tab. After making necessary changes to the input sheet, re-export the alternative by going to the "Generate Alternative" tab and clicking the button labeled "Click to replace an existing alternative with the same name". Update saved calculation sheets as described above.

Other Supporting Calculations:
Variation 1

% of Total Energy Usage from Renewable Resources

- According to eGRID (http://cfpub.epa.gov/egridweb/view_srl.cfm), the percentage of electricity from renewable sources for region NWPP is 50.93% (most of which is hydropower). Thus, it is assumed that 50.93% of the on-site electricity use is from renewable resources. The on-site electrical use is estimated at **21,135 MMBTU** in SiteWise. The total energy use (off-site and off-site) is estimated at **92,874 MMBTU**. Assuming all fuels used and all other energy use for production of materials are from non-renewable sources, then the % of total energy from renewable sources is **21,135** *.5093 / **92,789** = **11.6%**.

Hazardous Air Pollutants

- None identified

Refined Materials Use

Material	Lbs	Basis
Corn Syrup	**15,966,126**	LAPP-2 study: 94,400 lbs Inj. Tests: 306,244 lbs **First 3 yrs: 865,530 lbs** 2 Yrs Full Bio: 9,799,968 lbs 8 yrs Full Bio: 4,899,984
PVC	21,350	From SiteWise: 2 new EWs – 4,520 lbs Connecting pipe for new EWs – 16,830 lbs
Steel	758	From SiteWise: New IWs – 606 lbs Inj Test wells – 152 lbs
Stainless Steel	26,589	From SiteWise: EW piping – 1,868 lbs New IWs – 19,777 lbs Inj Test wells – 4,944 lbs
Cement	41,201	From SiteWise: 2 new EWs: 2,757 kg = 6,065 lbs New IWs: 12,777 kg = 28,109 lbs Inj well tests : 3,194 kg = 7,027 lbs
HDPE Pipe	3,616	From SiteWise: New IWs: 2,638 lbs Inj well tests : 978 lbs

Variation 1 – Other Supporting Calculations

Material	Lbs	Basis
Concrete	124,074	From SiteWise: 2 new EWs (slab): 13,428 kg = 29,542 lbs New IWs (pads): 34,375 kg = 75,625 lbs Inj well tests (pads): 8,594 kg = 18,907 lbs
GAC	**128,601**	**P&T: 42,867 lbs/yr * 3 yrs**
Total	***16,312,315 lbs***	

Unrefined Materials Use

Material	Tons	Basis
Gravel/crushed stone	580	From SiteWise: Backfill for EWs and IWs: 523,394kg = 576 tons New IWs filter pack: 3,067 kg = 3 tons Inj well tests filter pack: 767 kg = 1 ton

Tons of Non-Hazardous Waste

- **169 tons** based on transport of 55-gallon drums assumed in RACER assuming 8.33 lbs per gallon of waste

Tons of Hazardous Waste

- None identified

% of Potential Waste Recycled

- The GAC (used in the first **three years**) is recycled and is therefore not disposed. The estimate of GAC transported is **64.3 tons** over 3 years. Other waste (above) is **169 tons**. Therefore, the % of potential waste recycles is **64.3 / (64.3 + 169) = 28%**

Risks to On-Site Workers and from Transportation

- Based on SiteWise output
  - On-Site worker injuries or fatalities = 0.005
  - Transportation related injuries or fatalities = **0.172**

Heavy Truck Trips through Residential Areas

- None identified because residences are sparse and major roads lead to the site.

Project: GSR Pilot for Umatilla
Option or Alternative: Variation 1: Initial P&T and In-Situ Bio at Waste Lagoon for 3 Yrs Instead of 5 Yrs
Current Date: 2/7/2012

year	capital cost*	annual cost*	present value of cost each year	cumulative cash flow	
	(no discounting)	(no discounting)	7%	no discounting	7%
0	$3,793,884	$430,903	$4,224,787	$4,224,787	$4,224,787
1	$426,199	$644,378	$945,732	$5,295,363	$5,170,519
2	$528,032	$680,015	$997,357	$6,503,411	$6,167,876
3	$5,215,057	$334,233	$4,281,740	$12,052,701	$10,449,616
4	$0	$360,994	$260,315	$12,413,695	$10,709,931
5	$3,025,979	$360,683	$2,282,376	$15,800,357	$12,992,306
6	$0	$267,579	$168,532	$16,067,936	$13,160,839
7	$0	$254,815	$149,994	$16,322,751	$13,310,832
8	$0	$254,815	$140,181	$16,577,566	$13,451,013
9	$0	$254,815	$131,010	$16,832,381	$13,582,024
10	$0	$303,216	$145,696	$17,135,597	$13,727,720
11	$0	$254,815	$114,429	$17,390,412	$13,842,149
12	$0	$254,815	$106,943	$17,645,227	$13,949,093
13	$0	$514,318	$201,733	$18,159,545	$14,150,826
14	$0	$0	$0	$18,159,545	$14,150,826
15	$0	$0	$0	$18,159,545	$14,150,826
16	$0	$0	$0	$18,159,545	$14,150,826
17	$0	$0	$0	$18,159,545	$14,150,826
18	$0	$0	$0	$18,159,545	$14,150,826
19	$0	$0	$0	$18,159,545	$14,150,826
20	$0	$0	$0	$18,159,545	$14,150,826
21	$0	$0	$0	$18,159,545	$14,150,826
22	$0	$0	$0	$18,159,545	$14,150,826
23	$0	$0	$0	$18,159,545	$14,150,826
24	$0	$0	$0	$18,159,545	$14,150,826
25	$0	$0	$0	$18,159,545	$14,150,826
26	$0	$0	$0	$18,159,545	$14,150,826
27	$0	$0	$0	$18,159,545	$14,150,826
28	$0	$0	$0	$18,159,545	$14,150,826
29	$0	$0	$0	$18,159,545	$14,150,826
30	$0	$0	$0	$18,159,545	$14,150,826

*positive dollar value is a "cost", negative dollar value is a "savings"

Net Present Value (NPV)-> $14,150,826

Total of capital costs (undiscounted) -> $12,989,150
Total of annual costs (undiscounted) -> $5,170,395

The capital costs (no discounting) and annual costs (no discounting) are the same as the baseline alternative, except the capital and annual costs for "years 3 and 4" (which represent the 4th and 5th years of system operation) are eliminated, and the subsequent 10 years of annual costs are moved up two years. Capital costs for the substrate and transportation of the substrate, which are treated as capital costs in year 0 in the RACER analysis performed by the Project Team, are reduced by 40% versus the baseline (note this represents just a portion of the overall capital costs in year 0). Also, the capital costs after the initial two years are moved up by two years. In addition, the same assumption regarding future costs being incurred 83.263% into the year that was used in the baseline alternative is also applied here, so the two scenarios can be compared.

GSR Team Calculations to Split Energy Results from SiteWise into "Direct" and "Indirect"
Altrenative 4 (Variation 1)

phase	Reported by SiteWise		Assigned by GSR Team from SiteWise Output			Total Calculated by GSR Team
			Scope 1 (direct)	Scope 2 (indirect)	Scope 3 (indirect)	
	activity	energy used (MMBTU)	energy used (MMBTU)	energy used (MMBTU)	energy used (MMBTU)	
P&T System O&M – Uses "Remedial Investigation" tab	Consumables	1232.93	0.00	0.00	1232.93	1232.93
	Transportation-Personnel	99.23	0.00	0.00	99.23	99.23
	Transportation-Equipment	95.42	0.00	0.00	95.42	95.42
	Equipment Use and Misc	9875.76	3291.59	6584.17	0.00	9875.76
	Residual Handling	0.00	0.00	0.00	0.00	0.00
	Sub-Total	11303.34	3291.59	6584.17	1427.58	11303.34
Remedy Construction and Well Installation – Uses "Remedial Action Construction" tab	Consumables	1512.39	0.00	0.00	1512.39	1512.39
	Transportation-Personnel	72.82	0.00	0.00	72.82	72.82
	Transportation-Equipment	70.48	0.00	0.00	70.48	70.48
	Equipment Use and Misc	438.66	355.32	0.00	83.35	438.66
	Residual Handling	0.00	0.00	0.00	0.00	0.00
	Sub-Total	2094.36	355.32	0.00	1739.05	2094.36
Bioremediation (Including Studies and Testing) – Uses "Remedial Action Operations" tab	Consumables	58525.81	0.00	0.00	58525.81	58525.81
	Transportation-Personnel	146.96	0.00	0.00	146.96	146.96
	Transportation-Equipment	8843.74	0.00	0.00	8843.74	8843.74
	Equipment Use and Misc	11327.47	3808.20	7506.37	12.91	11327.47
	Residual Handling	28.49	0.00	0.00	28.49	28.49
	Sub-Total	78872.47	3808.20	7506.37	67557.91	78872.47
Monitoring and 5-Year Reviews – Uses "Longterm Monitoring" tab	Consumables	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	250.35	0.00	0.00	250.35	250.35
	Transportation-Equipment	268.10	0.00	0.00	268.10	268.10
	Equipment Use and Misc	0.00	0.00	0.00	0.00	0.00
	Residual Handling	0.00	0.00	0.00	0.00	0.00
	Sub-Total	518.45	0.00	0.00	518.45	518.45
total		92788.63	7455.11	14090.54	71242.99	92788.63

Note: Electricity use reported by SiteWise Version 2.0 in units of kWh is "Direct Scope 1", meaning it is energy consumed at the location of the project. However, energy use associated with electricity reported by SiteWise in units of MMBtu is a life-cycle value which also includes a factor to account for energy used elsewhere required to generate the electricity ("Indirect Scope 2"). Here, 33% of the life-cycle value reported by SiteWise is considered to be "Scope 1" on-site energy use, and 67% is considered to be "Scope 2" energy used in electricity generation.

SiteWise Version 2.0 uses fuel energy values from U.S. Department of Energy, Argonne National Laboratory, Transportation Technology R&D Center, GREET 1.8d.1, Fuel-Cycle model, 2010. This version of the GREET model reports that for Gasoline and Diesel, approximately 19% of GHG emissions are upstream emissions (scope 3) and 81% are tailpipe emissions (scope 1). For this analysis, it is assumed that energy is used in these same proportions, and therefore the energy use reported by SiteWise is split between scope 3 and scope 1 in these ratios.

GSR Team Calculations to Split GHG Results from SiteWise into "Direct" and "Indirect"
Alternative 4 (Variation 1)

phase	Reported by SiteWise		Assigned by GSR Team from SiteWise Output			Total Calculated by GSR Team
			Scope 1 (direct)	Scope 2 (indirect)	Scope 3 (indirect)	
	activity	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	GHG emitted (metric tons CO2e)	
P&T System O&M – Uses “Remedial Investigation” tab	Consumables	116.66	0.00	0.00	116.66	116.66
	Transportation-Personnel	7.89	0.00	0.00	7.89	7.89
	Transportation-Equipment	8.24	0.00	0.00	8.24	8.24
	Equipment Use and Misc	422.56	0.00	422.56	0.00	422.56
	Residual Handling	0.00	0.00	0.00	0.00	0.00
	Sub-Total	555.35	0.00	422.56	132.80	555.35
Remedy Construction and Well Installation – Uses “Remedial Action Construction” tab	Consumables	122.35	0.00	0.00	122.35	122.35
	Transportation-Personnel	5.61	0.00	0.00	5.61	5.61
	Transportation-Equipment	5.40	0.00	0.00	5.40	5.40
	Equipment Use and Misc	34.37	27.84	0.00	6.53	34.37
	Residual Handling	0.00	0.00	0.00	0.00	0.00
	Sub-Total	167.73	27.84	0.00	139.89	167.73
Bioremediation (Including Studies and Testing) – Uses “Remedial Action Operations” tab	Consumables	2408.76	0.00	0.00	2408.76	2408.76
	Transportation-Personnel	11.63	0.00	0.00	11.63	11.63
	Transportation-Equipment	997.19	0.00	0.00	997.19	997.19
	Equipment Use and Misc	487.39	4.56	481.77	1.06	487.39
	Residual Handling	2.18	0.00	0.00	2.18	2.18
	Sub-Total	3907.16	4.56	481.77	3420.83	3907.16
Monitoring and 5-Year Reviews – Uses “Longterm Monitoring” tab	Consumables	0.00	0.00	0.00	0.00	0.00
	Transportation-Personnel	19.83	0.00	0.00	19.83	19.83
	Transportation-Equipment	38.36	0.00	0.00	38.36	38.36
	Equipment Use and Misc	0.00	0.00	0.00	0.00	0.00
	Residual Handling	0.00	0.00	0.00	0.00	0.00
	Sub-Total	58.19	0.00	0.00	58.19	58.19
Total		4688.44	32.40	904.33	3751.71	4688.44

Note: CO2e reported by SiteWise Version 2.0 for electricity use is all associated with generation of the electricity (“Indirect Scope 2”).
SiteWise Version 2.0 use fuel emission factors from U.S. Department of Energy, Argonne National Laboratory, Transportation Technology R&D Center, GREET 1.8d.1, Fuel-Cycle model, 2010. This version of the GREET model reports that for gasoline and diesel, approximately 19% of GHG emissions are upstream emissions (Scope 3) and 81% are tailpipe emissions (Scope 1). For this analysis, the GHG emissions reported by SiteWise are split between Scope 3 and Scope 1 in these ratios.

Appendix C-2

Variation 2 – Ship Lab Samples to a Closer Lab

Appendix C-2
Assumptions for SiteWise Input and Other Calculations
Umatilla Chemical Depot Pilot GSR Evaluation:

Variation 2:
Ship Lab Samples to a Closer Lab

SiteWise "RA_Variation 2_NoFR_1" Directory

This variation on the baseline for Alternative 4 involves using a closer facility for laboratory analysis of collected samples. For the baseline footprinting, it is assumed that all samples are sent via air to ERDC in Vicksburg, MS, which has been used in the past for this site. The ERCD lab in MS has been used for pilot testing; but other accredited labs are used for compliance sampling. The Project Team indicates that the current contract for (semi-annual) compliance sampling is with a Wisconsin-based lab; and because WI and MS are roughly the same distance from Seattle (+/- 25%) the transport cost assumptions used in this evaluation are likely reasonable.

The footprint for lab shipments could be reduced if a closer lab was used. For quantifying an approximate footprint reduction for Variation 2, it is assumed that a lab in Seattle (~185 miles one-way) will be used to analyze all samples. Two possibilities were evaluated with SiteWise:

- Variation 2A - Assume that samples sent to Seattle will still be shipped overnight via air (FEDEX) calculated in SiteWise based on the weight of the material and the transport distance (to account for the fact that it shares the airplane with other items). Only the air portion is compared, the transport of the samples to and from the airports was not quantified (would likely be similar in both cases).

- Variation 2B – Assume samples sent to Seattle will still be shipped by ground (via FEDEX ground). Assume shipment represents 10% of a shared vehicle, so reduce mileage entered into SiteWise by 90% in all cases to account for the fact that only 10% of vehicle emissions would be caused by this shipment.

The remedy components to which this change applies are:

<u>P&T System O&M (initial phase, 5 years)</u>
Overnight delivery service, 21 to 50 lb packages .... 5*420 LB

<u>Single Monitoring Event during RA (2 week event requiring 2 people)</u>
Overnight delivery service, 51 to 70 lb packages .... 840 LB

<u>Monitoring for Initial 5 Years of P&T and bio injections (3 events per year, 2 weeks per event, requiring 2 people)</u>
Overnight delivery service, 51 to 70 lb packages .... 5*2460 LB

<u>Monitoring for First 2 Years of Full-Scale Bio (3 events per year, 2 weeks per event, requiring 2 people)</u>
Overnight delivery service, 51 to 70 lb packages .... 2*2460 LB

Variation 2 – Overview

Monitoring for Subsequent 8 Years of Full-Scale Bio (2 events per year, 2 weeks per event, requiring 2 people)

Overnight delivery service, 51 to 70 lb packages .... 8*1680 LB

Three SiteWise tabs were used:

- “Remedial Investigation” tab in SiteWise was used for air transport to Vicksburg, MS
- “Remedial Action Construction” tab in SiteWise was used for air transport to Seattle, WA
- “Remedial Action Operation” tab in SiteWise was used for ground transport to Seattle, WA

Variation 2 – SiteWise Inputs

Input for Baseline footprint into "Remedial Investigation" tab of SiteWise Input Sheet.xls

Assume shipments by air to ERDC Lab in Vicksburg, MS or a Wisconsin-based lab

- Transportation
  - Equipment Transportation – Air
    - Trip 1 – Overnight delivery service, 21 to 50 lb packages (assumed to be samples sent to lab). Assume one 35 lb package sent 1800 miles one way (to ERDC in Vicksburg, MS, which has been used in the past at this site) each month for 5 years. 1800 miles * 12 months per year * 5 years (108000 miles total), with a transport weight of 35 lbs (35/2000 = 0.0175 tons).
    - Trip 2 – Assumed empty coolers sent to site. Assume one 10 lb package sent 1800 miles one way each month for 5 years. 1800 miles * 12 months per year * 5 years (108000 miles total), with a transport weight of 10 lbs (10/2000 = 0.005 tons).
    - Trip 3 – Monitoring during RA, overnight delivery service, 51 to 70 lb packages (assumed to be samples sent to lab). Assume 14 coolers, 35 lbs average weight (10 lbs empty and 60 lbs full) each, sent 3600 miles round trip to ERDC, a previously used lab in Vicksburg, MS (assumed). 3600 miles, with a transport weight of 35 lbs * 14 coolers / 2000 = 0.245 tons.
    - Trip 4 – Initial 5 yr monitoring, overnight delivery service, 51 to 70 lb packages (assumed to be samples sent to lab). Assume 41 coolers per year for 5 years, 35 lbs average weight (10 lbs empty and 60 lbs full) each, sent 3600 miles round trip. 3600 miles, with a transport weight of 35 lbs * 41 coolers * 5 yrs / 2000 = 3.59 tons.
    - Trip 5 – 2 yr bio monitoring, overnight delivery service, 51 to 70 lb packages (assumed to be samples sent to lab). Assume 41 coolers per year for 2 years, 35 lbs average weight (10 lbs empty and 60 lbs full) each, sent 3600 miles round trip. 3600 miles, with a transport weight of 35 lbs * 41 coolers * 2 yrs / 2000 = 1.44 tons.
    - Trip 6 – 8 yr bio monitoring, overnight delivery service, 51 to 70 lb packages (assumed to be samples sent to lab). Assume 28 coolers per year for 8 years, 35 lbs average weight (10 lbs empty and 60 lbs full) each, sent 3600 miles round trip. For SiteWise input, assume diesel, 3600 miles, with a transport weight of 35 lbs * 28 coolers * 8 yrs / 2000 = 3.92 tons.

Variation 2 – SiteWise Inputs

<u>Input for Variation 2 footprint into "Remedial Action Construction" tab of SiteWise Input Sheet.xls</u>

Assume shipments by air to lab in Seattle, WA:

- Transportation
  - Equipment Transportation – Air
    - Trip 1 – Overnight delivery service, 21 to 50 lb packages (assumed to be samples sent to lab). Assume one 35 lb package sent 185 miles one way to Seattle each month for 5 years. 185 miles * 12 months per year * 5 years (11100 miles total), with a transport weight of 35 lbs (35/2000 = 0.0175 tons).
    - Trip 2 – Assumed empty coolers sent to site. Assume one 10 lb package sent 1800 miles one way each month for 5 years. 185 miles * 12 months per year * 5 years (11100 miles total), with a transport weight of 10 lbs (10/2000 = 0.005 tons).
    - Trip 3 – Monitoring during RA, overnight delivery service, 51 to 70 lb packages (assumed to be samples sent to lab). Assume 14 coolers, 35 lbs average weight (10 lbs empty and 60 lbs full) each, sent 370 miles round trip to Seattle. 370 miles, with a transport weight of 35 lbs * 14 coolers / 2000 = 0.245 tons.
    - Trip 4 – Initial 5 yr monitoring, overnight delivery service, 51 to 70 lb packages (assumed to be samples sent to lab). Assume 41 coolers per year for 5 years, 35 lbs average weight (10 lbs empty and 60 lbs full) each, sent 370 miles round trip. 370 miles, with a transport weight of 35 lbs * 41 coolers * 5 yrs / 2000 = 3.59 tons.
    - Trip 5 – 2 yr bio monitoring, overnight delivery service, 51 to 70 lb packages (assumed to be samples sent to lab). Assume 41 coolers per year for 2 years, 35 lbs average weight (10 lbs empty and 60 lbs full) each, sent 370 miles round trip. 370 miles, with a transport weight of 35 lbs * 41 coolers * 2 yrs / 2000 = 1.44 tons.
    - Trip 6 – 8 yr bio monitoring, overnight delivery service, 51 to 70 lb packages (assumed to be samples sent to lab). Assume 28 coolers per year for 8 years, 35 lbs average weight (10 lbs empty and 60 lbs full) each, sent 370 miles round trip. For SiteWise input, assume diesel, 370 miles, with a transport weight of 35 lbs * 28 coolers * 8 yrs / 2000 = 3.92 tons.

Variation 2 – SiteWise Inputs

Input for Variation 2 footprint into "Remedial Action Operation" tab of SiteWise Input Sheet.xls

Assume shipments by ground to lab in Seattle, WA:

******Assume shipment represents 10% of a shared vehicle, so reduce mileage entered by 90% in all cases to account for the fact that only 10% of vehicle emissions would be caused by this shipment***

- Transportation
  - Equipment Transportation – Road
    - Trip 1 – Overnight delivery service, 21 to 50 lb packages (assumed to be samples sent to lab). Assume one 35 lb package sent 185 miles one way to Seattle each month for 5 years. 185 miles * 12 months per year * 5 years * 0.1 (1110 miles total), with a transport weight of 35 lbs (35/2000 = 0.0175 tons).
    - Trip 2 – Assumed empty coolers sent to site. Assume one 10 lb package sent 1800 miles one way each month for 5 years. 185 miles * 12 months per year * 5 years * 0.1 (1110 miles total), with a transport weight of 10 lbs (10/2000 = 0.005 tons).
    - Trip 3 – Monitoring during RA, overnight delivery service, 51 to 70 lb packages (assumed to be samples sent to lab). Assume 14 coolers, 35 lbs average weight (10 lbs empty and 60 lbs full) each, sent 370 miles round trip to Seattle. 370 miles * 0.1 = 37 miles, with a transport weight of 35 lbs * 14 coolers / 2000 = 0.245 tons.
    - Trip 4 – Initial 5 yr monitoring, overnight delivery service, 51 to 70 lb packages (assumed to be samples sent to lab). Assume 41 coolers per year for 5 years, 35 lbs average weight (10 lbs empty and 60 lbs full) each, sent 370 miles round trip. 370 miles * 5 yrs * 0.1 = 185, with a transport weight of 35 lbs * 41 coolers / 2000 = 0.7175 tons.
    - Trip 5 – 2 yr bio monitoring, overnight delivery service, 51 to 70 lb packages (assumed to be samples sent to lab). Assume 41 coolers per year for 2 years, 35 lbs average weight (10 lbs empty and 60 lbs full) each, sent 370 miles round trip. 370 miles * 2 yrs * 0.1 = 74, with a transport weight of 35 lbs * 41 coolers / 2000 = 0.7175 tons.
    - Trip 6 – 8 yr bio monitoring, overnight delivery service, 51 to 70 lb packages (assumed to be samples sent to lab). Assume 28 coolers per year for 8 years, 35 lbs average weight (10 lbs empty and 60 lbs full) each, sent 370 miles round trip. For SiteWise input, assume diesel, 370 miles * 8 yrs * 0.1 = 296, with a transport weight of 35 lbs * 28 coolers / 2000 = 0.49 tons.

Cost Summary

Costs were not evaluated in detail, but it is assumed that ground transportation to Seattle (Variation 2B) would have the lowest cost, and air transport to Seattle (Variation 2A) would have lower cost than the Baseline. The Project Team notes the following: "Normally this would be a reasonable assumption, but for compliance monitoring the lowest-cost lab was in Wisconsin even though a cost proposal was received from a Seattle-area lab. Current contract criteria call for 'lowest cost bid which is technically acceptable.' FEDEX transport costs (at least under USACE account utilized for sample shipment) to the lab are based on weight of shipment and not on transport distance or whether it went via air or ground.

Variation 2 – SiteWise Inputs

Therefore, in order for GSR considerations like reduced greenhouse gas emissions to be considered, they would need to be written into contracts (which may not even be possible with overnight shipping companies) and would not always result in lower cost.”

Final Report

GREEN AND SUSTAINABLE REMEDIATION
PILOT PROJECT EVALUATION
SCHILLING AIR FORCE BASE ATLAS MISSILE FACILITY S-1

Minneapolis, Kansas

Property Number B07KS0259

Prepared for:

U.S. Army Corps of Engineers
Kansas City District
Kansas City, Missouri

Prepared by:

U.S. Army Corps of Engineers
Environmental and Munitions Center of Expertise
Omaha, Nebraska

14 March 2012

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Preface

The US Army Engineering and Support Center, Huntsville (USAESCH), Environmental and Munitions Center of Expertise (EM CX) is conducting and documenting a Study that follows the process of considering, incorporating, documenting, and evaluating the benefits of green and sustainable remediation (GSR) practices. The objective of this Task Order is to: (1) Follow the consideration and incorporation of GSR practices into Army environmental remediation projects; (2) Ascertain the effectiveness of the GSR practices that are considered and incorporated; and (3) Provide procedures by which GSR practices that are shown to be effective can be identified, considered, implemented and documented by Project Teams working on Army sites. The information obtained from this Study will be used to provide recommendations to the Office of the Assistant Chief of Staff for Installation Management (OACSIM) for development of Army-wide GSR guidance and policy.

The Project Delivery Team (Project Team) consists of representatives and subject matter experts (SMEs) from the following organizations:

- EM CX;
- OACSIM;
- National Guard Bureau (NGB);
- Army Environmental Command (AEC);
- Tetra Tech;
- Office of the Deputy Assistant Secretary of the Army-Environmental Safety and Occupational Health (ODASA [ESOH]);
- Headquarters US Army Corps of Engineers (HQ [USACE]) Formerly Used Defense Sites (FUDS) program;
- HQ USACE Environmental Community of Practice (ECoP) Military Munitions Support Services (M2S2);
- Environmental Protection & Utility Branch US Army Engineering and Support Center, Huntsville
- Army Environmental Policy Institute (AEPI)

Specific representatives of those organizations are listed on the table at the end of this preface. This report pertains to one of the pilot projects conducted as part of the Study. It is noted that although a contractor, Tetra Tech, is conducting some of the GSR evaluations for the EM CX, this GSR evaluation was prepared for the Project Team directly by the EM CX. Persons who provided the most significant contributions to this GSR evaluation are as follows:

- GSR Evaluation
    - Anita Meyer
    - Thomas Georgian
    - Chung-Rei Mao
    - Dave Becker
    - Carl Harms
    - Ed Bave
    - Mike Bailey
    - Mark Fisher

- Report Preparation
    - Carl Harms
    - Carol Lee Dona (EM CX Study lead)

- Review
    - Mike Bailey
    - Dave Becker
    - Sarah Farron (Tetra Tech)
    - Rob Greenwald (Tetra Tech)
    - USACE Kansas City (CENWK) Project Delivery Team (PDT)

Sincere thanks are extended to the Schilling Atlas S-1 Project Team associated with this pilot project, for their willingness to participate in this Study and for efforts associated with their participation. The Schilling Project Team participants are included in Section 1.3.

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Professional in Charge:

Carol Dona, Study Project Manager, Ph.D, P.E. 3/14/2012
Date

Acronyms and Abbreviations

AEC	Army Environmental Command
AEPI	Army Environmental Policy Institute
BMPs	Best Management Practices
CENWK	Corps of Engineers Northwest Division, Kansas City District
COCs	Contaminants of Concern
COR	Contracting Officer Representative
CSM	Conceptual Site Model
DCE	cis-1,2-dichloroethene
DO	Dissolved Oxygen
DOD	Department of Defense
ECoP	Environmental Community of Practice
EM CX	Environmental and Munitions Center of Expertise
ESOH	Environmental Safety and Occupational Health
FUDS	Formerly Used Defense Sites
GAC	Granular Activated Carbon
GHG	Greenhouse Gas
GSA	General Services Administration
GSR	Green and Sustainable Remediation
HAP	Hazardous Air Pollutants
HQUSACE	Headquarters United States Army Corps of Engineers
IDW	Investigation Derived Waste
IRP	Installation Restoration Program
KDHE	Kansas Department of Health and Environment
KO	Contracting Officer
LCC	Launch Control Center
MCL	Maximum Contaminant Level
MMRP	Military Munitions Response Program
M2S2	Military Munitions Support Services
MNA	Monitored Natural Attenuation
MW-XX	Monitoring Well (XX refers to the number of the well)
NDAI	No DOD Action Indicated
NGB	National Guard Bureau
OACSIM	Office of the Assistant Chief of Staff for Installation Management
OCRWD2	Ottawa County Rural Water District #2
ODASA	Office of the Deputy Assistant Secretary of the Army
ORP	Oxidation Reduction Potential
PA	Preliminary Assessment
PDBs	Passive Diffusion Bags
PDT	Project Delivery Team
PID	Photoionization Detector
POTW	Publicly Owned Treatment Works
RI	Remedial Investigation
SI	Site Inspection
TCE	Trichloroethene
The Site	The former Schilling Air Force Base Atlas F Missile Site S-1

The Study	The study following inclusion of GSR for OACSIM
USACE	United States Army Corps of Engineers
USAESCH	United States Army Engineering and Support Center, Huntsville
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound

Section 1: INTRODUCTION

1.1 ACSIM GSR Study and Purpose of this GSR Evaluation

The US Army Engineering and Support Center, Huntsville (USAESCH), Environmental and Munitions Center of Expertise (EM CX) is conducting and documenting a Study that follows the process of considering, incorporating, documenting, and evaluating the benefits of green and sustainable remediation (GSR) practices (hereafter referred to as "the Study"). The objective of the Study is to: (1) Follow the consideration and incorporation of GSR practices into Army environmental remediation projects; (2) Ascertain the effectiveness of the GSR practices that are considered and incorporated; and (3) Provide procedures by which GSR practices that are shown to be effective can be identified, considered, implemented and documented by Project Teams working on Army sites. The information obtained from this Study will be used to provide recommendations to the Office of the Assistant Chief of Staff for Installation Management (OACSIM) for development of Army-wide GSR guidance and policy.

One component of the Study described above is to perform a GSR evaluation at 12 Army "Pilot Projects" that are in various phases of the remedial process. This report presents the Pilot Project GSR Evaluation at the Schilling S-1 Atlas F Missile Site near Minneapolis, Kansas (hereafter referred to as the Site). The Site is currently in the Site Inspection (SI) phase, with the potential of the project continuing into the Remedial Investigation (RI) phase. This GSR evaluation has been conducted using an approach developed during the Study and documented in the following report: *Process for Consideration and Incorporation of Green and Sustainable Remediation (GSR) Practices in Army Environmental Remediation (26 May 2011)*. One purpose for the pilot projects is to provide testing of the GSR approach developed during the Study, and that approach will be refined and finalized later in the Study based on lessons learned from this and other pilot projects. In addition, it is anticipated that this GSR evaluation will provide the Project Team for the Schilling S-1 Atlas Site with information and/or recommendations that will be beneficial for their project.

This report refers to "teams" that are defined as follows:

- Study Team: This is the team conducting the Study being led by USACE EM CX that follows the process of considering, incorporating, documenting, and evaluating the benefits of green and sustainable remediation practices for Army projects.
- Project Delivery Team (PDT): Refers to those associated with implementation of the remedial process for the pilot projects. For this report the Project Team consists of USACE personnel from the Kansas City District.
- GSR Team: Refers to the personnel that perform a specific GSR evaluation. For this report, the GSR Team consists of personnel from the EM CX.

In this Study, an “EM CX liaison” for each of the pilot projects serves as a bridge between the USACE Study project manager (Carol Dona) and the Project Team manager (Saqib Khan) for the specific pilot. For this pilot project the EM CX liaison is Carol Dona.

1.2 Technical Overview: Schilling S-1 Atlas F Missile Facility

1.2.1 Site Location and Historical Use

The Schilling S-1 Atlas F Missile Facility (the Site) is located within Ottawa County, Kansas near the intersection of N 210th Road and Justice Road. It is roughly 5 miles north-east of the city of Bennington, and eight miles east of the city of Minneapolis. The legal location of the Site is within Section 16, Township 11 South, Range 2 West at the coordinates: 39^{0} 05’ 57” North, 97^{0} 32’ 36” West (see Figure 1-1). The property that was originally purchased by the Department of Defense (DOD) was an area of approximately 250 acres. Within the DOD property only a portion of the total area (approximately 18.4 acres) was actually used during operations; the rest of the land acted as a buffer zone between the central operations area and surrounding land. The portion of the land that was used during DOD operations is where the Site Inspection (SI) activities that are the focus of this GSR evaluation occur.

The missile launch facilities located at the Site were constructed between 1959 and 1961. In total, twelve missile bases were constructed within a 35 mile radius around the Schilling Air Force Base located in Salina, Kansas. The Atlas F missile bases stored a single missile on-site in a 52-foot inside diameter, 174-foot deep underground silo. In addition to the underground silo, an underground launch control center (LCC) was constructed, consisting of a concrete structure with a 40-foot inside diameter that had a total depth of 27 feet. Other ancillary equipment and structures that were located at the Site include two water wells, water treatment systems, tanks for storing water and diesel fuel, and piping systems for water, fuel, septic waste, and rocket propellant.

The Site was activated in 1962 and was operational until November of 1964 when the DOD announced that all Atlas F missile bases were to be deactivated. In 1966 the Site was declared to be excess, and in 1969 the Site was sold by the General Services Administration (GSA) to the Kansas State Board of Education. The Site has had multiple owners following the original sale.

1.2.2 Current Site Condition

The major structures remaining from past DOD activity include the missile silo, the launch control center (both located underground), and a water treatment building. Additional structures include a security fence and a concrete pad that the administration building (since removed) sat on. Existing groundwater resources on-site include a single monitoring well (referred to as MW-01 in the project documents) that has been used as a residential water supply well at times according to the property owner and the five additional monitoring wells (MW-02 to MW-06) that were installed during the SI field work . Just outside of the site boundary, the Ottawa County Rural Water District #2 (OCRWD2) has installed 13 wells to perform a wellfield test to determine if the underlying aquifer is suitable for water production. Boring logs, results from aquifer pump tests, and groundwater sampling data have been shared with CENWK by OCRWD2.

The current landowner uses the Site as a private residence. A Right of Entry agreement has been made between the landowner and the Project Team. Although OCRWD2 is conducting field investigations, the Site is not yet connected to any Publicly Owned Treatment Works (POTWs). USACE has notified the rural water district about the potential for contamination of the soils and/or groundwater near the Site. The Project Team intends to share the results of the Site Inspection (SI) with OCRWD2 when possible.

1.2.3 Past Investigation for Contamination

In 1985 an initial site visit was conducted at the Schilling S-1 location. Following the initial site visit, a Site Sampling Plan was developed by CENWK and Hunter/ESE Inc. based on additional site visits and interviews with the current land owner. In the spring of 1989 sampling was conducted by installing MW-01, sampling the standing water in the missile silo, and collecting six shallow soil samples. The results of the study indicated that there was no evidence of chemical contamination of the groundwater or missile silo water. Many of the soil samples showed elevated levels of acetone, arsenic, barium, chromium, lead, and mercury; however Hunter/ESE Inc. concluded that these results were consistent with standard regional values and background levels. The activities resulted in the assignment of a No DOD Action Indicated (NDAI) status to the Schilling S-1 Site in September of 1990.

In 2001, the Kansas Department of Health and the Environment (KDHE) issued a report stating that they did not believe sufficient data had been collected during the initial investigation to conclude that the Site was not contaminated. KDHE gave the Site a High Relative Ranking, indicating that they wished to see further site evaluation including the installation of additional groundwater monitoring wells.

Tetra Tech EC Inc. conducted a Preliminary Assessment (PA) of the Site in 2005 for the United States Environmental Protection Agency (USEPA), collecting and analyzing the following:

- Groundwater samples from the on-site monitoring well, the missile silo standing water, and five residential production wells (one of which was for background testing)
- Three surface water samples and three sediment samples
- Fourteen Geoprobe soil samples

The results of the testing led USEPA to conclude that risks to human health were minimal at the Site. However, since measurable amounts of trichloroethene (TCE) were found in the monitoring well sample, USEPA determined that a documented release of contaminants to the environment had occurred due to past DOD activity.

In 2008, CENWK completed a PA report in which they concluded that there was sufficient evidence to state that the contamination pathway was complete for groundwater. This claim is based on the fact that there is a documented release of TCE and that there are known target receptors (domestic production wells downgradient of the well in which TCE was detected). In response to these findings, CENWK began to collect quarterly samples from MW-01 in April 2009. Samples were analyzed for volatile organic compounds (VOCs), including TCE and its degradation daughter product *cis*-1,2-dichloroethene (DCE). In August 2010 analysis of samples showed TCE above its maximum contaminant level (MCL) of 5.0 µg/L. The reported value of 5.7 µg/L represents the first sample for which TCE exceeded its MCL. DCE has never been detected above its MCL of 70 µg/L.

1.2.4 Site Investigation Activities

Based on the historical use of the site and observations from other Atlas F missile sites, the Project Team has identified five potential areas where contaminants of concern (COCs) may be located:

- Inside the silo, where groundwater has leaked in and collected
- The soils in the vicinity of the silo, which may have been exposed to potentially contaminated groundwater from the silo
- The discharge point of the silo sump
- The sand filter bed for the septic tank system
- An evaporation pond where water released from the on-site water treatment system was sent

The Project Team completed a Site Inspection (SI) Work Plan for expanded exploration of the Schilling S-1 site in April 2011 and work was performed during the summer of 2011. The plan addresses identified data gaps by installing additional wells for groundwater sampling and collecting soil samples (see Figure 1-2 for a site map with the location of proposed wells)

Five monitoring wells were installed across the site. Soil samples were taken from the boring for each monitoring well and from two additional locations. The Project Team used a photoionization detector (PID) to help determine where soil samples should be taken, with soil samples to be collected where the PID measurements were the highest. The Project Team reported that the PID meter did not detect any contamination at a reasonable level, so soil samples were taken from fine-grain zones that are the most likely locations for contamination.

1.3 Documents Reviewed and Calls/Meetings Conducted

For this GSR evaluation, the following documents were reviewed:

- *Site Inspection Draft Final Work Plan: Schilling Air Force Base Atlas F Missile Facility S-1 (CENWK, April 2011)*

- *Preliminary Assessment Report: Schilling Air Force Base Atlas F Missile Facility S-1 (CENWK, October 2008)*

Communication between the GSR study lead (Carol Dona) and the Project Team project manager (Saqib Khan) was initiated by phone on 17 May 17 2011, with follow-up emails describing the activities that would involve participation of the Project Team in the Study. Mr. Khan agreed to Project Team participation, and the documents referred to above were sent to the GSR Team for review.

The list of 63 GSR Best Management Practices (BMPs), as included in Appendix A of this report, was used as the primary structure for identification of GSR opportunities. The Study Team performed an initial evaluation of the list of BMPs as they applied to the SI Work Plan. This evaluation was sent to the Project Team for review in advance of a conference call between the Study Team and the Project Team. During the conference call (referred to as the "Step 5" call), the Study Team was able to request any additional information that was needed to complete the GSR evaluation. The Project Team was also able to provide feedback on the list of BMPs. Participants in the Step 5 call are listed below in Table 1-1.

Table 1-1 Step 5 Conference Call Participants

Name	Organization	Email
Carol Dona	EM CX	carol.l.dona@usace.army.mil
Mike Bailey	EM CX	michael.m.bailey@usace.army.mil
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1.4 Structure of Report

The evaluation performed by the GSR Team is structured as follows:

- Section 1: Introduction
- Section 2: Consideration of Site-Specific Application of the GSR Evaluation
- Section 3: GSR Review of SI Work Plan
    - Review of BMP tables
    - Other Considerations
    - Quantitative Analysis of the Footprint of selected Site activities
- Section 4: GSR Recommendations
- Appendix A: Best Management Practices
- Appendix B: Calculation of Baseline Footprint

- Appendix C1: Alternative Footprint 1: Off-Site Disposal of Investigation-Derived Waste (IDW)
- Appendix C2: Alternative Footprint 2: Comparison of Alternate Drilling Methods
- Appendix C3: Case Study (Joint Base Fort Lewis-McChord): Comparison of Passive Diffusion Bag Vs. Low-Flow Sampling

Section 2: CONSIDERATION OF SITE-SPECIFIC APPLICATION OF THE GSR EVALUATION PROCESS

The timeframe under which this GSR evaluation occurred played an important role in how the current GSR evaluation process applied to the specific work being done at the Site. The work planned for the Site came to the attention of the Study Lead (Carol Dona) approximately one month before field activities were scheduled to begin. Schedule limitations meant that the Step 5 call could not be conducted until after field work had already begun. To accommodate project constraints imposed by the schedule, the GSR Team identified three categories on which to focus the review of the Work Plan:

- The first focus was to review the Work Plan and identify GSR BMPs that had already been implemented or were planned for implementation by the Project Team. During the Step 5 call, these BMPs were briefly discussed to allow the Project Team to mention if any significant changes had occurred concerning them.
- A second focus was BMPs that could have been implemented by the Project Team. This latter set of BMPs was discussed with the Project Team during the Step 5 call to determine if implementation of those BMPs would have been feasible for this Site.
- The third focus was to identify BMPs that could be applicable to the Site in the future. Since the Project Team expressed that it is possible that the Site will advance to a Remedial Investigation (RI), the GSR Team identified this as an opportunity to provide valuable information to the Project Team by making recommendations for that could apply to an RI.

Section 3: KEY GSR FINDINGS

3.1 Review of Best Management Practices (BMPs)

This GSR evaluation was performed by considering the BMP tables in Appendix A that were originally developed by Tetra Tech for use in the Study GSR evaluation approach. The BMPs are "*actions or considerations that are expected to improve an environmental, social, or economic aspect of the remedial process*" according to the report prepared by Tetra Tech titled *Process for Consideration and Incorporation of Green and Sustainable Remediation (GSR) Practices in Army Environmental Remediation (26 May 2011).*

An example of a BMP, BMP F-2, and its specific application to the Schilling S-1 site is included in Figure 3-1. The effort that goes into categorizing a BMP can be summarized in three steps.

- The first step in considering a BMP is to determine if that BMP is "Applicable". BMPs are considered "Applicable" if they could potentially be performed at the specific Site and for the specific remediation process. For the Site, BMP F-2 is considered "Applicable" because it addresses on-site water use, an activity which does occur at the Site.
- If a BMP is "Applicable", it can be evaluated. During the Step 5 call, the Project Team did not mention any considerations of looking for less refined water sources as opposed to bringing in potable water from an offsite source. Therefore, the BMP would not be considered "Evaluated". Lastly, if a BMP has been designated as "Evaluated" then it can be classified as "Practical" or "Impractical" based on the results of evaluation. In this case, since the BMP was not evaluated, the practicality of the BMP was not considered.

The BMP tables are also meant to be dynamic. This is demonstrated in Figure 3-2, which is an imagined scenario for how the assessment of BMP F-2 could change in the future. If the Project Team were able to find a suitable non-potable water source in the vicinity of the Site, then they could evaluate using that source for the water needed for drilling mud. If the evaluation was favorable, then the Project Team would more than likely apply BMP F-2 for the site work. It is noted that if the PDT was investigating use of non-potable water, the non-potable water source would need to first be tested to ascertain whether it was appropriate for use.

BMP F-2: Preferentially use less refined water resources when feasible Examples: • Use extracted groundwater instead of potable water for chemical blending • Capture and store rain/storm water for future use • Employ rumble grates with a closed-loop gray-water washing system	08/31/11 ☑ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☑ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ <$10,000 ☐ $10,001-$50,000 ☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000
Resources Conserved: ☐ Hazardous Air Pollutants ☐ Energy ☐ Waste ☐ Criteria Pollutants ☐ Materials ☐ Safety/Community ☐ GHG Emissions ☐ Water ☐ Land Use	☐ BMP Otherwise Required If so, required by:
Notes: The only activity that requires any water consumption is drilling (water for mud preparation and for equipment decontamination). There are no nearby streams, so the PDT would need to coordinate with either the landowner or the rural water district to obtain water. This coordination to obtain water may represent too great of an effort for it to be worthwhile.	

Figure 3-1 Initial Evaluation of a BMP

BMP F-2: Preferentially use less refined water resources when feasible Examples: • Use extracted groundwater instead of potable water for chemical blending • Capture and store rain/storm water for future use • Employ rumble grates with a closed-loop gray-water washing system	09/10/11 ☑ Applicable ☑ Evaluated ☑ Practical
Implemented? ("N/A" if "Practical" not checked) ☑ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☑ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☑ Environmental ☑ Economic ☑ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ <$10,000 ☐ $10,001-$50,000 ☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000
Resources Conserved: ☐ Hazardous Air Pollutants ☑ Energy ☐ Waste ☐ Criteria Pollutants ☑ Materials ☐ Safety/Community ☐ GHG Emissions ☑ Water ☐ Land Use	☐ BMP Otherwise Required If so, required by:
Notes: Drillers are collecting all of the water needed for drilling mud make-up from a local production well.	

Figure 3-2 Potential Future Evaluation of a BMP

A summary of the BMP evaluation is given in Table 3-1 below.

Table 3-1 Summary of BMP Evaluation

	BMP Category									
	A. Planning	B. Characterization and/or Remedy Approach	C. Energy/Emissions Transportation	D. Energy/Emissions Equipment Use	E. Materials & Off-site Services	F. Water Resource Use	G. Waste Generation, Disposal, and Recycling	H. Land Use, Ecosystems, and Cultural Resources	I. Safety and Community	J. Miscellaneous
Total Number of BMPs	10	9	4	11	5	5	6	7	7	2
Number of Applicable BMPs	9	6	4	4	4	4	5	3	4	2
Number of Practical BMPs	8	5	3	1	2	3	4	2	4	2
Number of BMPs Implemented Prior to GSR Evaluation										
- Fully	5	4	1	0	1	1	1	0	4	2
- Partially	2	1	1	0	1	0	0	1	0	0
- Not Yet	1	0	1	1	0	2	3	1	0	0
Number of Practical BMPs Likely to Result in Cost Savings	4	5	3	1	2	1	3	1	1	0

3.1.1 Qualitative Findings from BMP Evaluation

During the process of evaluating the BMPs, several themes were noted. One important idea is that the time and effort spent evaluating each BMP category was not equal and is dependent on the phase of work that is being performed. Since the Site is currently in the SI phase, the GSR Team spent the majority of its time evaluating BMPs related to planning (Category A) and characterization and sampling (Category B). Similarly, certain BMP categories such as equipment and material use (Category D & Category E) required very little discussion and analysis since the activities associated with those BMPs did not apply to the activities being performed during the SI phase for this Site.

Conditions specific to the Site also played a large role in determining which BMPs were evaluated more thoroughly. Specifically, the fact that the Site is owned privately and not by DOD meant that BMPs related to land reuse and structure reuse were generally not applicable. Furthermore, the Project Team had stated that they were very conscientious about minimizing disturbance to the Site since obtaining the Right of Entry had been difficult. Therefore, BMPs related to Land Disturbance and Safety/Community (Categories H and I respectively) were carefully considered by the Project Team, with this reflected in the GSR evaluation.

In general, the BMPs can be divided into three categories. First there are the BMPs that the Project Team had already considered and implemented before the GSR evaluation. Second, there are BMPs that could be implemented but have not yet been implemented. Finally, there are many BMPs that are not applicable or practical for this Site. A discussion of each category is included below.

- **Implemented BMPs**: While the Project Team had not explicitly included documentation of BMPs related to the consideration of GSR in their Work Plan, it was clear from the review of the Work Plan and the discussion during the Step 5 call that several of the BMPs were being implemented.
    - The Project Team had made significant efforts to develop relationships with the land owner and OCRWD2.
    - The relationship with the OCRWD2 has given the Project Team the option to sample existing wells which were installed in the vicinity of the Site. In addition, the Project Team and the water district are exchanging the results of their sampling near the Site. This gives the Project Team the benefit of having data over a larger areal extent without having to install new wells.
    - Chemical sampling data is sent electronically, not as a hard copy. In addition, the Project Team has limited their paper consumption by utilizing a network drive to share files and by pre-printing labels and field forms.
    - Teleconferences and email have been used in place of physical meetings with the interested parties.
    - A thorough review of project documents for similar Atlas missile sites was conducted. This allowed the Project Team to optimize their sampling and characterization efforts.
    - The Project Team made an effort to collect real time data using a PID. While this represents an attempt to implement real-time data collection, the PID did not provide any detections which could be used by the Project Team to determine where to collect soil samples.

- A thorough Conceptual Site Model (CSM) was developed for the Site. This helps to limit the scope of any work that is done by focusing efforts on areas that are believed to be contaminated.
- The Project Team has re-used bladder pumps for groundwater sampling and a polyethylene tank used for storing liquid Investigation Derived Waste (IDW). Each of those items was brought over from a different remediation site.
- The Project Team has communicated with regulators concerning disposal of IDW generated during the well installation process. Currently the Project Team believes that testing will allow for them to dispose of all IDW on-site by land farming drill cuttings and applying liquid IDW to the ground surface following treatment in a portable granular activated carbon (GAC) unit.

- **BMPs Which Could be Applied**: During the Work Plan evaluation and Step 5 call, the Project Team and GSR Team identified several BMPs that could possibly be implemented during the SI phase for projects similar in nature to the one reviewed. Some of these BMPs could also be implemented if the Site advances to the RI phase.
  - The Project Team may want to consider developing a section dedicated to GSR consideration in future reports and work plans. This could apply to any work going forward at this Site as well as SIs at other sites.
  - With reference to well installation, the Project Team mentioned that progress was very slow due to both equipment issues and worker schedules. During the Step 5 call, it was proposed that alternate work schedules (an extended work week) for the drillers could minimize the number of mobilization and demobilizations to the Site, thereby reducing the environmental impact associated with more frequent mobilization and demobilization to the Site.
  - Currently, the selection of in-house drilling crews limits the drilling technologies that are available. The Project Team may want to consider the benefits of using other drilling crews that have a wider range of equipment available, some of which could be more green and sustainable (See Appendix C2).
  - Currently, the Project Team is testing groundwater for a limited number of geochemical parameters while extracting water for low-flow sampling. The Project Team may want to consider the benefits of collecting all of the standard geochemical parameters , i.e.

the parameters used to determine the potential of monitored natural attenuation (MNA), concurrently with low-flow sampling. Currently, KDHE requires that one year of low-flow sampling be performed before switching to passive diffusion bags (PDBs). If the Project Team still needs to collect a full suite of geochemical parameters after one year of sampling, this could delay the opportunity to switch from low-flow sampling to PDBs.

  - Since all of the disposable materials used on-site need to be taken off-site for disposal, the Project Team may want to evaluate if it would be worthwhile to bring separate containers for recyclables and disposables to the Site. This would allow for them to segregate recyclables, such as plastics, metals, glass, and paper, instead of throwing them away.
  - During some of the field work, vehicle ruts were created at the Site following a heavy rain storm. The Project Team indicated that their concern about not disturbing the Site had been expressed to the drillers. An option that the Project Team may want to consider is developing a location plan showing areas that may be prone to damage or areas that the land owner does not want to be used. The Project Team said that a lesson learned would be to educate the drill crew about what activities could result in damage to the property or privacy infringement to the land owner. These activities would then be more likely avoided.
  - While the Project Team has stated their optimism that IDW can be disposed of on-site, it may be beneficial to have conversations with the land owner to identify the owner's constraints on where an acceptable amount of IDW can be disposed of on-site

- **BMPs Which Are Not Applicable**: Finally, there are several categories of BMPs that did not apply to this Site because they address work that does not occur during the SI phase. These BMPs would also be expected to be generally not applicable in other FUDS projects in the SI and RI phases.
  - Most of the BMPs in Category D were not applicable since they are related to optimization of the equipment used. The only equipment used during the SI has been a drill rig.
  - All BMPs related to land reuse were not applicable since the Site is no longer owned by DOD. In addition, considering options like adding renewable energy would be

complicated since it could be perceived as making improvements to land that USACE does not own.

 - BMPs related to material selection were not generally applicable since the focus of those BMPs is on selecting recycled or less-refined materials. There were no activities that could use those types of materials.

3.2 Quantitative Footprint Analysis for Site Inspection Activities

An additional way of considering GSR is to perform a footprint evaluation of the activities involved in performing the SI. Calculation of the footprint was performed by reviewing workplans and other project documents and then asking follow up questions to the Project Team. Once all of the data had been gathered and any necessary assumptions were made, the SiteWise Version 2 tool was used to perform the calculations needed to generate a footprint.

Generally, footprint calculations consider different alternatives that have been proposed for consideration but have not yet been performed. For this Site the work for the SI has already been performed, and the “alternatives” that are proposed are not actually under consideration for implementation at the Site. The purpose of including a footprint calculation is to follow the format of other studies being done for OACSIM (see Section 1.1) and to provide a quantitative footprint that could be of benefit to the Project Team. The scenarios that are evaluated for this Site are:

- Baseline: This scenario models the actual activities that occurred on-site during the SI.
- Alternative 1: An alternate method of waste disposal was assumed for this scenario
- Alternative 2: A different drilling method was assumed for this scenario

Calculations and notes clarifying assumptions made for the footprint calculations are included in Appendices B, C1, and C2. A brief description of each scenario is included below, followed by a summary of the results comparing the different scenarios.

In addition to the footprints for the alternative scenarios listed above, a case study at Joint Base Lewis-McChord in Washington State is included in Appendix C3 that compares the comparative impacts of low-flow sampling vs. passive diffusion bag (PDT) sampling. As the project team has indicated its preference to move from low-flow sampling to PDT sampling when approved by the regulators, this case study can potentially be used qualitatively at this site in any additional investigative work, as well as other SI and RI investigations.

3.2.1 Baseline Scenario for SI Activities

The significant activities which contributed to the footprint calculation for the baseline scenario include:

- Mobilization and demobilization of personnel and drilling equipment to the Site. Additional vehicle trips to hotels and shipping drop off locations are included as well.

- Using mud rotary drilling to complete seven boreholes to an approximate depth of 80 feet below ground, collecting soil samples from each of the boreholes, and installing wells in five of the seven borings.
- Collecting groundwater samples from the newly installed monitoring wells using low-flow sampling techniques.
- Shipping the groundwater and soil samples by air to an analytical lab located in Michigan.
- Handling, storing, and treating IDW that is generated by on-site activities. For the baseline scenario, liquid IDW generated by drilling was treated with on-site GAC units, and drill cuttings were containerized and ultimately dumped on-site.

3.2.2 Alternative 1: Off-site Disposal of IDW

Alternative 1 was developed to analyze the footprint of disposing of all IDW off-site as opposed to the on-site disposal that was done in the baseline scenario. The activities that are assumed for alternative 1 are:

- Mobilization and demobilization of personnel and drilling equipment to the Site. Additional vehicle trips to hotels and shipping drop off locations are included as well.
- Using mud rotary drilling to complete seven boreholes to an approximate depth of 80 feet below ground, collecting soil samples from each of the boreholes, and installing wells in five of the seven borings.
- Collecting groundwater samples from the newly installed monitoring wells using low-flow sampling techniques.
- Shipping the groundwater and soil samples by air to an analytical lab located in Michigan.
- Picking up all liquid IDW using multiple trips from a sump truck to carry the IDW off-site to a disposal location 30 miles from the Site. Picking up all solid IDW in a single trip and transporting it to the same landfill where liquid IDW is sent

3.2.3 Alternative 2: Drilling with a Roto-Sonic Drill Rig

Another consideration was to analyze whether using a different type of drill rig would have GSR benefits. In order to provide the most straightforward comparison between alternative 2 and the baseline scenario, the waste disposal methods and driller schedules are the same for both methods.

- Mobilization and demobilization of personnel and drilling equipment to the Site. Additional vehicle trips to hotels and shipping drop off locations are included as well.
- Using roto-sonic drilling to complete seven boreholes to an approximate depth of 80 feet below ground, collecting soil samples from each of the boreholes, and installing wells in five of the seven borings.
- Collecting groundwater samples from the newly installed monitoring wells using low-flow sampling techniques.
- Shipping the groundwater and soil samples by air to an analytical lab located in Michigan.
- Handling, storing, and treating IDW that is generated by on-site activities. For this alternative there are no drilling fluids so the only liquid IDW generated is for equipment decontamination.

As in the baseline scenario, liquid IDW is treated on-site with a portable GAC unit. Drill cuttings are also containerized and subsequently disposed of on-site like in the baseline scenario.

One concern when considering the use of roto-sonic drilling is the geographic availability of a roto-sonic drill rig. Since roto-sonic is a newer technology there are not as many roto-sonic drill rigs available, and in some cases the nearest contractor using roto-sonic drilling may be several hundred miles away. For this alternative it was assumed that a roto-sonic drill rig would have the same mobilization distance as the mud rotary rig used in the other scenarios since there is a contractor in Kansas City that offers roto-sonic drilling (WDC Exploration).

3.2.4 Summary of Quantitative Footprint Results for all Scenarios

Table 3-2 summarizes the quantitative footprint results that are found using the SiteWise Version 2 footprint calculation tool. The SiteWise files used for this footprint calculation are supplied electronically.

Table 3-2 Summary of Quantitative Footprint

GSR Parameter	Baseline	Alternative 1	Alternative 2
Environmental			
Energy – Total (MMBtu)	282	283	168
% of Energy from Renewable Resources (1)	None	None	None
Global warming potential – Total (Metric tons CO_2e)	22.83	22.78	13.44
Criteria air pollutant emissions (Metric tons NOx + SOx + PM10)	0.19	0.19	0.08
Hazardous air pollutant emissions (Lbs) (2)	Not Quantified	Not Quantified	Not Quantified
Potable water use (1000s of gallons)	14	14	0.39
Other water use (1000s of gallons)	None	None	None
Refined materials use (Tons)	1.7	1.4	1.5
% of refined materials from recycled material	Not Quantified	Not Quantified	Not Quantified
Unrefined materials use (Tons)	5.2	5.2	5.2
% of unrefined materials from recycled material	Not Quantified	Not Quantified	Not Quantified
Non-hazardous waste generation (Tons)(3)	0.00	6.97	0.00
Hazardous waste generation (Tons)	0.00	0.00	0.00
% of potential waste that is recycled or re-used	Not Quantified	Not Quantified	Not Quantified
Societal			
Predicted number of injuries or fatalities for On-Site Worker	2.1×10^{-3}	2.1×10^{-3}	2.2×10^{-3}
Predicted number of injuries or fatalities associated with transportation	7.9×10^{-3}	8.2×10^{-3}	7.9×10^{-3}
One-Way Heavy Vehicle Trips through Res. Area	None	None	None

(1) *The only energy used on-site would be from fossil fuel powered generators, which is not renewable.*

(2) *Hazardous air pollutants (HAPs) are primarily produced by air strippers without off-gas treatment. A minute amount of HAPs are produced by fuel consumption, but this is negligible.*

(3) *Although in reality liquid IDW would be considered non-hazardous waste, it is not counted as waste in the footprinting since the SiteWise tool calculates an environmental footprint for any*

non-hazardous waste entered into the tool. Since the liquid IDW is treated on-site in scenarios 1 and 3 and placed in evaporative ponds in scenario 2, there is no footprint for disposal of the IDW.

3.2.5 Key Findings from Quantitative Footprint Analysis

From Table 3-2, it is apparent that in terms of environmental footprint, the Baseline scenario and Alternative 1 are very similar. The only area in which the two have a significant difference is in the amount of hazardous waste generated since Alternative 1 involves sending drill cuttings off-site to a landfill. Hazardous waste generation accounts for a minute portion of the greenhouse gas (GHG) emissions and energy use as evident in Figures 3-3 and 3-4. It is evident from Table 3-2 that Alternative 2 has the least impact of all three scenarios in terms of GHG emissions, water use, and air emissions.

Figures 3-3 and 3-4 also provide additional information on the activities that have the greatest environmental impact for each scenario. It is evident that fueling the drill rigs (Equipment Use and Misc) provides the most significant contribution, followed by personnel and equipment transportation. Alternative 2 has the overall smallest footprint since fueling the drill rigs is the greatest contributor to environmental footprint. This is due to the fact that roto-sonic and mud rotary drill rigs both have the same production rate, but mud rotary drill rigs consume fuel at a higher rate (the SiteWise tool assumes that mud rotary rigs use nearly 3 times the fuel of roto-sonic drill rigs).

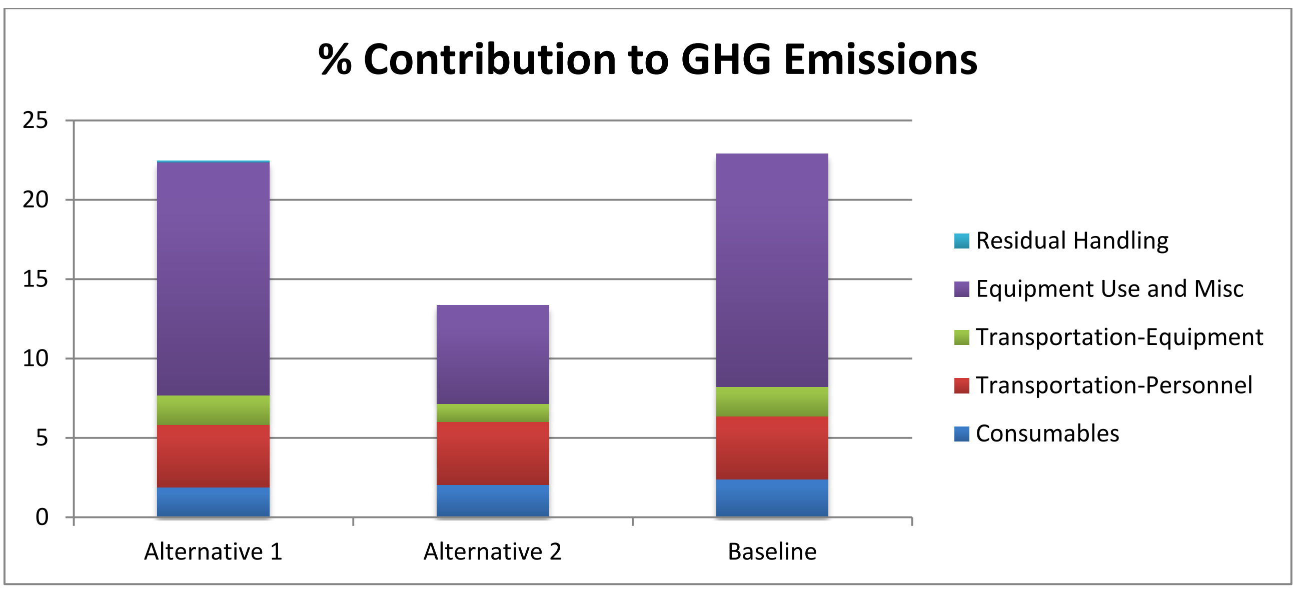

Figure 3-3 Activity Contribution to Total GHG Emissions

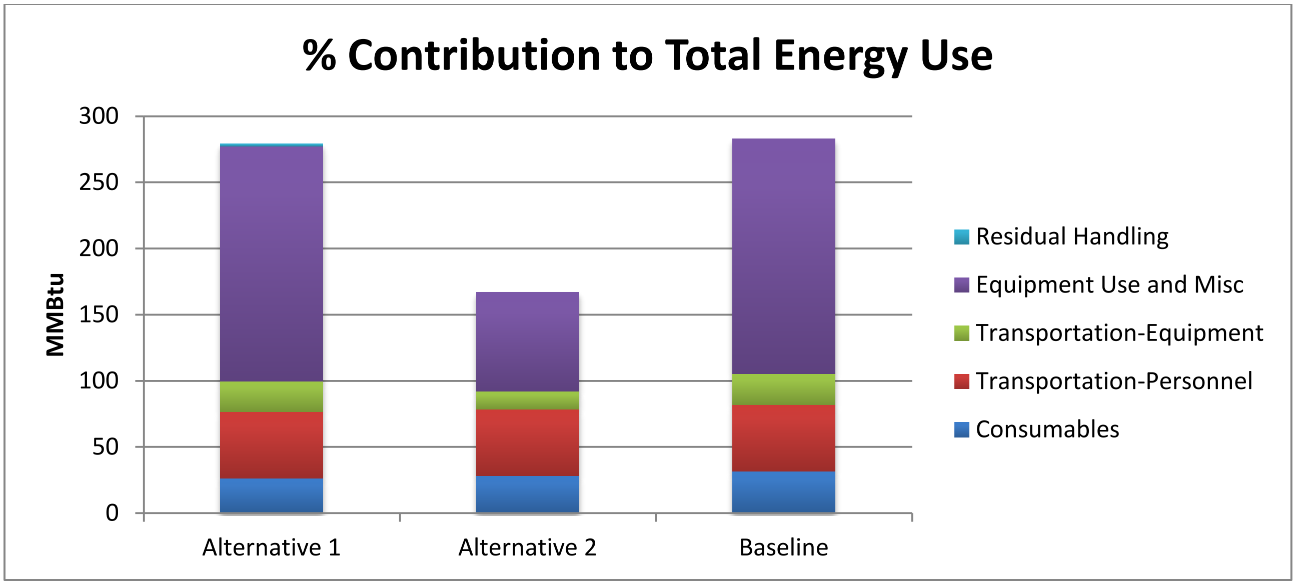

Figure 3-4 Activity Contribution to Total Energy use

Section 4: GSR Recommendations

One of the goals of performing a GSR evaluation is to develop recommendations that can be used by the Project Team. Since this GSR evaluation occurred in a unique timeframe (see Section 2 for more details), the Study Team was not able to make recommendations that could be implemented for the SI Work Plan. However, the Project Team had stated that they believed that the Site would eventually progress into the RI phase, so the Study Team developed recommendations that could be implemented by the Project Team if an RI did occur at the Site.

The recommendations provided by the GSR Team are meant for the consideration of the Project Team. They are not required and implementation of any recommendation is based on the Project Team's determination of GSR benefits and site-specific applicability.

Tracking tables are provided for the benefit of the Project Team. Should the Project Team choose to include sections on GSR in future projects, the tracking tables can be updated to show the progress of GSR consideration at the Site.

Table Number	Recommendation
4-1	4.1 Include a section dedicated to GSR in each report, work plan, and project meeting.
4-2	4.2 Consider collecting a full suite of geochemical parameters during the SI.
4-3	4.3 Determine if different drilling methods are suitable for the Site.
4-4	4.4 Determine if different schedules are suitable for the Site.
4-5`	4.5 Change the groundwater sampling method from low-flow to passive diffusion bag (PDB).
4-6	4.6 Develop site location plans that highlight areas where vehicles (or other activities) may cause unwanted disturbance.
4-7	4.7 Obtain an agreement with the landowner concerning on-site IDW disposal.
4-8	4.8 Consider electronic capture of field data.
4-9	4.9 Bring containers to the Site to separate recyclables from trash.

Table 4-1 Tracking Table for Recommendation 4.1

<table>
<tr><td colspan="2" rowspan="2">Recommendation:

4.1 – Include a section that documents GSR considerations in each meeting, work plan, and report.</td><td>Current Date:
09/21/2011</td></tr>
<tr><td>Date of Original Recommendation:
09/21/2011</td></tr>
<tr><td colspan="3">Basis for Recommendation (Include Discussion of Cost Impacts and Value if Appropriate):

The Project Team did not specifically include any sections on GSR in the work plan that was written for the Site; however, many of the considerations in the BMP tables were applied by the Project Team. While this shows that the Project Team has made a point of being good stewards of resources, formal documentation of GSR considerations would be in keeping with DOD policy.</td></tr>
<tr><td colspan="3">Resources Conserved:
☐ Hazardous air pollutants ☐ GHG emissions (CO2e) ☐ Energy ☐ Water ☐ Waste
☐ Criteria pollutants ☐ Safety/Community ☐ Materials ☐ Land-use</td></tr>
<tr><td>Qualitative Net Cost Impact Over 5 Years, No Discounting

☐ Cost Increase ☐ Cost Savings
☐ Cost Neutral ☒ N/A</td><td colspan="2">☐ Recommended action otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="3">Attachment(s) to Report with Footprint Assumptions and Calculations:

Not applicable. This recommendation is not based on quantitative considerations such as footprint calculation of one alternative versus another.</td></tr>
<tr><td>Implementation Status:

☐ Fully
☐ Partially
☒ Not Yet
☐ Not Planned</td><td colspan="2">Explanation of Status:

This is a new recommendation to be considered by the Project Team. While none of the resource conservation or cost savings boxes have been checked, it is possible that those items could be an indirect benefit of including GSR sections in reports and documents.</td></tr>
</table>

Table 4-2 Tracking Table for Recommendation 4.2

<table>
<tr><td colspan="2">Recommendation:

4.2 – Consider collecting the full suite of geochemical parameters needed to determine if Monitored Natural Attenuation (MNA) is a viable option.</td><td>Current Date: 09/21/2011

Date of Original Recommendation: 09/21/2011</td></tr>
<tr><td colspan="3">Basis for Recommendation (Include Discussion of Cost Impacts and Value if Appropriate):

The SI work plan states that collection of Dissolved Oxygen (DO), Oxidation Reduction Potential (ORP), conductance, pH, temperature, and turbidity will occur during low-flow sampling of the groundwater. The Project Team has also stated that KDHE typically prefers one year of low-flow sampling before a site can switch to PDBs. Since the Project Team expects that the Site will progress to the RI phase, it may be worthwhile to collect a full suite of MNA parameters while low-flow sampling equipment is still at the Site (since the PDT expressed strong interest in using PDBs once allowed). The PDT should evaluate the potential benefits and costs associated with collecting a complete list of geochemical data all at once versus collecting some data now and the rest in the future.</td></tr>
<tr><td colspan="3">Resources Conserved:
☐ Hazardous air pollutants ☐ GHG emissions (CO2e) ☐ Energy ☐ Water ☐ Waste
☐ Criteria pollutants ☐ Safety/Community ☐ Materials ☐ Land-use</td></tr>
<tr><td>Qualitative Net Cost Impact Over 5 Years, No Discounting

☐ Cost Increase ☐ Cost Savings
☐ Cost Neutral ☐ N/A</td><td colspan="2">☐ Recommended action otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="3">Attachment(s) to Report with Footprint Assumptions and Calculations:

Not applicable. This recommendation is not based on quantitative considerations such as footprint calculation of one alternative versus another.</td></tr>
<tr><td>Implementation Status:

☐ Fully
☐ Partially
☒ Not Yet
☐ Not Planned</td><td colspan="2">Explanation of Status:

This recommendation is new for the PDT to consider. By collecting all of the geochemical parameters during sampling in the first year, the Project Team could avoid an additional round of low-flow sampling and could switch to PDBs at an earlier date. This has the potential to reduce the time of sampling within a sampling round (sampling with PDBs take less time than low-flow sampling) and/or the number of sampling trips, thereby resulting in cost savings.</td></tr>
</table>

Table 4-3 Tracking Table for Recommendation 4.3

<table>
<tr><td colspan="2">Recommendation:

4.3 —Consider different drilling techniques (Applicable for future activities at the Site as well as other sites in the SI/RI stage).</td><td>Current Date:
09/21/2011
Date of Original Recommendation:
09/21/2011</td></tr>
<tr><td colspan="3">Basis for Recommendation (Include Discussion of Cost Impacts and Value if Appropriate):

During the Step 5 call, the PDT stated that delays occurred during well installation due to inadequacy of equipment . The PDT has tried to balance multiple decision factors by selecting an in-house drilling crew instead of hiring a contractor. The selection of in-house drilling crews has limited the available drilling equipment and has delayed well installation progress.</td></tr>
<tr><td colspan="3">Resources Conserved:
☒ Hazardous air pollutants ☒ GHG emissions (CO2e) ☒ Energy ☒ Water ☒ Waste
☒ Criteria pollutants ☒ Safety/Community ☒ Materials ☒ Land-use</td></tr>
<tr><td>Qualitative Net Cost Impact Over 5 Years, No Discounting

☐ Cost Increase ☒ Cost Savings
☐ Cost Neutral ☐ N/A</td><td colspan="2">☐ Recommended action otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="3">Attachment(s) to Report with Footprint Assumptions and Calculations:

Attachment C2 contains calculations and assumptions for the footprinting of using roto-sonic drilling as opposed to mud-rotary drilling, the latter of which was used at the Site.</td></tr>
<tr><td>Implementation Status:

☐ Fully
☐ Partially
☒ Not Yet
☐ Not Planned</td><td colspan="2">Explanation of Status:

The footprinting of the roto-sonic vs mud-rotary drilling methods indicated that the roto-sonic drilling method has the potential to have a lower GSR footprint than mu-rotary drilling. However, the footprint calculation provides only a portion of the analysis that would be required in order to have a sound basis for considering a change in drilling methods or schedules. Evaluations of cost, social benefit, and geologic applicability would also need to occur. Since regional availability and site geology play such a large role in the GSR benefit of different drilling techniques, it should be noted that the evaluation of the above check boxes could be subject to change based on site-specific information.</td></tr>
</table>

Table 4-4 Tracking Table for Recommendation 4.4

<table>
<tr><td colspan="2">Recommendation:

4.4 —Consider different schedules (Applicable for future activities at the Site as well as other sites in the SI/RI stage).</td><td>Current Date: 01/06/2012
Date of Original Recommendation: 01/-6/2012</td></tr>
<tr><td colspan="3">Basis for Recommendation (Include Discussion of Cost Impacts and Value if Appropriate):

During the Step 5 call, the PDT stated that the drill crew drove to the Site each week from Kansas City on Monday and drove back on Fridays. The time spent in commuting limited the available time each week for performing work on the Site and increased the mobilizations to and from the site. The PDT has tried to balance multiple decision factors by selecting an in-house drilling crew instead of hiring a contractor.. Alternate deployment schedules that would likely be available if a contractor was used that would have the crews stay at the site for more days before returning could reduce the overall number of mobilization events and result in GSR savings (less fuel used, fewer hours spent driving, etc.), as well as cost savings.</td></tr>
<tr><td colspan="3">Resources Conserved:
☒ Hazardous air pollutants ☒ GHG emissions (CO2e) ☒ Energy ☒ Water ☒ Waste
☒ Criteria pollutants ☒ Safety/Community ☒ Materials ☒ Land-use</td></tr>
<tr><td>Qualitative Net Cost Impact Over 5 Years, No Discounting

☐ Cost Increase ☒ Cost Savings
☐ Cost Neutral ☐ N/A</td><td colspan="2">☐ Recommended action otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="3">Attachment(s) to Report with Footprint Assumptions and Calculations:

This recommendation was not quantitatively evaluated because multiple delays from weather and equipment malfunction did not allow quantitative calculation of base and alternative schedules.</td></tr>
<tr><td>Implementation Status:

☐ Fully
☐ Partially
☒ Not Yet
☐ Not Planned</td><td colspan="2">Explanation of Status:

This is currently not implemented but could be implemented in any subsequent investigation phases, i.e. the RI if performed.</td></tr>
</table>

Table 4-5 Tracking Table for Recommendation 4.5

<table>
<tr><td colspan="2">Recommendation:

4.5 – Switch the groundwater sample collection method from low-flow sampling to Passive Diffusion Bags (PDBs) as soon as possible.</td><td>Current Date: 09/21/2011
Date of Original Recommendation: 09/21/2011</td></tr>
<tr><td colspan="3">Basis for Recommendation (Include Discussion of Cost Impacts and Value if Appropriate):

This was a recommendation brought up by the GSR Team during early correspondence with the Project Team. The Project Team has stated that KDHE prefers seeing one year of traditional (i.e. low-flow) sampling before allowing for a switch to PDBs.</td></tr>
<tr><td colspan="3">Resources Conserved:
☒ Hazardous air pollutants ☒ GHG emissions (CO2e) ☒ Energy ☒ Water ☒ Waste
☒ Criteria pollutants ☒ Safety/Community ☒ Materials ☐ Land-use</td></tr>
<tr><td>Qualitative Net Cost Impact Over 5 Years, No Discounting

☐ Cost Increase ☒ Cost Savings
☐ Cost Neutral ☐ N/A</td><td colspan="2">☐ Recommended action otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="3">Attachment(s) to Report with Footprint Assumptions and Calculations:

Although GSR footprints of low-flow sampling and PDBs were not quantified for the Site, a case study with quantitative footprint comparison was prepared based on the sampling program for the Joint Base Lewis-McCord in Washington State. The results indicate that passive diffusion bag sampling has the potential to have a lower GSR footprint than low-flow sampling. Although the results from the Joint Base Lewis-McCord differ quantitatively from those expected at the Schilling S-1 site because of different site-specific conditions, the general conclusions about the GSR footprint reduction from PDB use is expected to be applicable at the S-1 site for future investigation and also in other SI and RI investigations. This case study is included in Attachment C-3.</td></tr>
<tr><td>Implementation Status:

☐ Fully
☐ Partially
☒ Not Yet
☐ Not Planned</td><td colspan="2">Explanation of Status:

As stated, the PDT has shown interest in changing sampling technology to PDBs when it is allowed by regulators. Since the contaminants being tested for are suitable for PDB sample collection, it does not appear that there are any impediments to eventually using PDBs.</td></tr>
</table>

Table 4-6 Tracking Table for Recommendation 4.6

Recommendation: *4.6 – Develop a location plan for field workers that highlights areas where vehicles should not be driven or other areas where the landowner is concerned about disturbance.*	Current Date: 09/21/2011 Date of Original Recommendation: 09/21/2011
Basis for Recommendation (Include Discussion of Cost Impacts and Value if Appropriate): *This recommendation came about due to the PDT mentioning that vehicle ruts had been made at the Site following a rain storm. While the PDT stated that they always remind field crews to be careful not to disturb land, it may be helpful for crews to know in advance which areas should be avoided and which areas are safe to drive vehicles on.*	
Resources Conserved: ☒ Hazardous air pollutants ☒ GHG emissions (CO2e) ☒ Energy ☐ Water ☐ Waste ☒ Criteria pollutants ☒ Safety/Community ☐ Materials ☒ Land-use	
Qualitative Net Cost Impact Over 5 Years, No Discounting ☐ Cost Increase ☐ Cost Savings ☒ Cost Neutral ☐ N/A	☐ Recommended action otherwise required? If checked, required by:
Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000 ☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000	
Attachment(s) to Report with Footprint Assumptions and Calculations: *None. This recommendation deals generally with the Community/Land Use aspect of GSR. However, although not quantified, there were additional costs because of the damage to the site, which included two site visits to document the damage, the cost of the labor to document, review, and approve repairs to the damage, and the cost to repair the damage. There was also additional fuel, and the related air emissions, and energy used in the trips to arrange for and coordinate the repair. The costs and other GSR metrics were not quantified*	
Implementation Status: ☐ Fully ☐ Partially ☒ Not Yet ☐ Not Planned	Explanation of Status: *This is a new recommendation to the PDT. This recommendation would only apply to the Site if additional work and/or visits are required. This recommendation can be viewed as having a broad application to virtually any remediation project requiring field work.*

Table 4-7 Tracking Table for Recommendation 4.7

<table>
<tr><td colspan="2" rowspan="2">Recommendation:

4.7 – Consult with the landowner about where IDW can be placed on-site and how much IDW the landowner is comfortable with having dumped on-site.</td><td>Current Date:
09/21/2011</td></tr>
<tr><td>Date of Original Recommendation:
09/21/2011</td></tr>
<tr><td colspan="3">Basis for Recommendation (Include Discussion of Cost Impacts and Value if Appropriate):

This recommendation is a follow up to a GSR practice that the PDT plans to implement. The PDT believes that regulators will allow on-site disposal of liquid and solid IDW. It was not stated during the Step 5 call whether or not the PDT had spoken with the landowner concerning on-site IDW disposal. On-site disposal of IDW reduces trips to pick up and transport waste and also saves landfill space, both of these are considered environmental benefits.</td></tr>
<tr><td colspan="3">Resources Conserved:
☐ Hazardous air pollutants ☐ GHG emissions (CO2e) ☐ Energy ☒ Water ☒ Waste
☐ Criteria pollutants ☒ Safety/Community ☐ Materials ☒ Land-use</td></tr>
<tr><td>Qualitative Net Cost Impact Over 5 Years, No Discounting

☐ Cost Increase ☐ Cost Savings
☒ Cost Neutral ☐ N/A</td><td colspan="2">☐ Recommended action otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☒ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="3">Attachment(s) to Report with Footprint Assumptions and Calculations:

Appendix C1 includes calculations and assumptions for disposing of IDW off-site. This differs from the actual site work, in which all IDW was disposed on-site.</td></tr>
<tr><td>Implementation Status:

☐ Fully
☐ Partially
☒ Not Yet
☐ Not Planned</td><td colspan="2">Explanation of Status:

This is a new recommendation to the PDT. This recommendation would only apply to the Site if additional work and/or visits are required. This recommendation could apply to any site where significant amounts of IDW are generated and on-site disposal is the preferred method of handling IDW.</td></tr>
</table>

Table 4-8 Tracking Table for Recommendation 4.8

<table>
<tr><td colspan="2" rowspan="2">Recommendation:

4.8 – Consider electronic capture of field data</td><td>Current Date:
9/2/2011</td></tr>
<tr><td>Date of Original Recommendation:
9/2/2011</td></tr>
<tr><td colspan="3">Basis for Recommendation (Include Discussion of Cost Impacts and Value if Appropriate):

The Project Team identified potential opportunities to electronically capture and record field data, specifically sample collection locations and chain of custody forms. Electronic capture in the field would be expected to eliminate hard copy forms as well as time spent by the Project Team in transcription of results from field forms to electronic forms. The potential for transcription errors, and the time spent by Project Team members verifying transcription accuracy would also be reduced. The Project Team supported both electronic capture of data for any potential future investigations (SI/RI) as well as development of standard USACE procedures for electronically capturing field data.</td></tr>
<tr><td colspan="3">Resources Conserved:
☐ Hazardous air pollutants ☐ GHG emissions (CO2e) ☐ Energy ☐ Water ☒ Waste
☐ Criteria pollutants ☐ Safety/Community ☒ Materials ☐ Land-use</td></tr>
<tr><td colspan="2">Qualitative Net Cost Impact Over 5 Years, No Discounting

☐ Cost Increase ☒ Cost Savings
☐ Cost Neutral ☐ N/A</td><td>☐ Recommended action otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="3">Attachment(s) to Report with Footprint Assumptions and Calculations:

It is likely that there is some level of up-front cost involved with implementing this recommendation, but quantification has not been performed.</td></tr>
<tr><td>Implementation Status:

☐ Fully
☐ Partially
☒ Not Yet
☐ Not Planned</td><td colspan="2">Explanation of Status:

During the Step 5 call, the Project Team expressed a desire to implement electronic recording of field data. In addition, members of the Project Team stated that they have made ongoing efforts to help in the development and implementation of USACE policy for field capture. However, the Project Team mentioned that implementing electronic recording of field data has not been successful to date.</td></tr>
</table>

Table 4-9 Tracking Table for Recommendation 4.9

<table>
<tr><td colspan="2" rowspan="2">Recommendation:

4.9 – Consider bringing containers on-site for segregation of recyclables and disposables</td><td>Current Date:
09/21/2011</td></tr>
<tr><td>Date of Original Recommendation:
09/21/2011</td></tr>
<tr><td colspan="3">Basis for Recommendation (Include Discussion of Cost Impacts and Value if Appropriate):

The PDT mentioned that all manufactured materials used in the investigations had to be taken off-site for disposal since the Site is privately owned. No mention of recycling practices was made so it is likely that all materials are disposed of in the same containers and eventually thrown away as trash. Field crews could separate recyclables into their own containers, such as containers for paper, plastic, glass, and metal, and then dispose of them as recyclable when they demobilized.</td></tr>
<tr><td colspan="3">Resources Conserved:
☐ Hazardous air pollutants ☐ GHG emissions (CO2e) ☐ Energy ☐ Water ☒ Waste
☐ Criteria pollutants ☒ Safety/Community ☒ Materials ☐ Land-use</td></tr>
<tr><td>Qualitative Net Cost Impact Over 5 Years, No Discounting

☐ Cost Increase ☐ Cost Savings
☒ Cost Neutral ☐ N/A</td><td colspan="2">☐ Recommended action otherwise required?
If checked, required by:</td></tr>
<tr><td colspan="3">Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Negligible ☐ < $10,000 ☐ $10,001 - $50,000
☐ $50,001 - $100,000 ☐ $100,001 - $500,000 ☐ > $500,000</td></tr>
<tr><td colspan="3">Attachment(s) to Report with Footprint Assumptions and Calculations:

Not applicable. This recommendation requests that the PDT perform a quantitative evaluation.</td></tr>
<tr><td>Implementation Status:

☐ Fully
☐ Partially
☒ Not Yet
☐ Not Planned</td><td colspan="2">Explanation of Status:

This is a new recommendation for the PDT to consider. The primary consideration that would need to be made is whether or not enough recyclable materials are produced on-site to warrant separation. The boxes that are filled out above assume benefits based on the PDT implementing this recommendation as it is intended.</td></tr>
</table>

Figures

APPENDIX A

Best Management Practices Tables

BMP A-1: Develop a culture of GSR within the project team and encourage GSR ideas from project staff

09/20/11

☑ Applicable
☑ Evaluated
☑ Practical

Implemented?
("N/A" if "Practical" not checked)

☑ Fully ☐ Partially ☐ Not Yet ☐ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):

☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☑ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):

☑ Environmental ☑ Economic ☑ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:

☑ Negligible ☐ <$10,000 ☐ $10,001-$50,000
☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000

Resources Conserved:

☑ Hazardous Air Pollutants ☑ Energy ☑ Waste
☑ Criteria Pollutants ☑ Materials ☑ Safety/Community
☑ GHG Emissions ☑ Water ☑ Land Use

☐ BMP Otherwise Required

If so, required by:

Notes:

The PDT has been very enthusiastic during the GSR study thus far and the Project Manager indicated that the PDT is interested and willing to continue involvement in the GSR study. The PDT has also made several efforts independently to consider and implement BMPs that have positive sustainability benefits.

BMP A-2: Incorporate a section on GSR in project meetings, work plans, and reports

09/20/11

☑ Applicable
☑ Evaluated
☑ Practical

Implemented?
("N/A" if "Practical" not checked)

☐ Fully ☐ Partially ☑ Not Yet ☐ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):

☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☑ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):

☑ Environmental ☑ Economic ☑ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:

☐ Negligible ☐ <$10,000 ☐ $10,001-$50,000
☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000

Resources Conserved:

☑ Hazardous Air Pollutants ☑ Energy ☑ Waste
☑ Criteria Pollutants ☑ Materials ☑ Safety/Community
☑ GHG Emissions ☑ Water ☑ Land Use

☐ BMP Otherwise Required

If so, required by:

Notes:

The SI report written by the PDT did not contain a section dedicated to GSR considerations, but the PDT did express interest in possibly including a GSR section in future documents for this site.

BMP A-3: Identify and periodically update a list of key stakeholders and their concerns with respect to GSR considerations	09/20/11 ☑ Applicable ☑ Evaluated ☑ Practical

Implemented? ("N/A" if "Practical" not checked)	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
☑ Fully ☐ Partially ☐ Not Yet ☐ N/A	☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☑ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☑ Environmental ☑ Economic ☑ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ <$10,000 ☐ $10,001-$50,000 ☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000
Resources Conserved: ☑ Hazardous Air Pollutants ☑ Energy ☑ Waste ☑ Criteria Pollutants ☑ Materials ☑ Safety/Community ☑ GHG Emissions ☑ Water ☑ Land Use	☐ BMP Otherwise Required If so, required by:

Notes:

The PDT has made significant efforts to communicate with the current stakeholders and involved parties (the landowner, rural water district, and Kansas Department of Health and the Environment [KDHE]).

BMP A-4: Schedule activities for appropriate seasons and/or time of day to reduce delays caused by weather conditions and minimize or eliminate fuel needed for heating or cooling Examples: • Work at night in summer to avoid heat stress • Perform field activities in summer to take advantage of longer daylight	09/20/11 ☑ Applicable ☑ Evaluated ☑ Practical

Implemented? ("N/A" if "Practical" not checked)	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
☐ Fully ☑ Partially ☐ Not Yet ☐ N/A	☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☑ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☑ Environmental ☑ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ <$10,000 ☐ $10,001-$50,000 ☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000
Resources Conserved: ☑ Hazardous Air Pollutants ☑ Energy ☐ Waste ☑ Criteria Pollutants ☐ Materials ☐ Safety/Community ☑ GHG Emissions ☐ Water ☐ Land Use	☐ BMP Otherwise Required If so, required by:

Notes:

Scheduling for the field work was largely driven by the desire to utilize funding before the end of the fiscal year. In-house drilling crews were also available for a limited time only since they become very busy beginning in April. Since the project was scheduled during the summer there are both benefits (from the longer daylight availability) and delays (due to extreme heat).

BMP A-5: Prepare, store, and distribute documents electronically	09/20/11 ☑ Applicable ☑ Evaluated ☑ Practical

Implemented? ("N/A" if "Practical" not checked)	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
☑ Fully ☐ Partially ☐ Not Yet ☐ N/A	☐ Cost Increase ☑ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):	Level of Up-Front Investment Included in 5 Year Cost Impact:
☑ Environmental ☑ Economic ☐ Social	☐ Negligible ☐ <$10,000 ☐ $10,001-$50,000 ☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000

Resources Conserved:	☐ BMP Otherwise Required
☑ Hazardous Air Pollutants ☑ Energy ☑ Waste ☑ Criteria Pollutants ☑ Materials ☐ Safety/Community ☑ GHG Emissions ☐ Water ☐ Land Use	If so, required by:

Notes:

The PDT has a designated network drive available for sharing project documents. All data from the laboratory is stored electronically in ADBR. In addition the PDT pre-prints forms and labels for field crews to use.
There was significant discussion about efforts that members of the PDT have taken to work with EM CX personnel to develop a Corps-wide method for electronically taking and storing data.

BMP A-6: Utilize teleconferences rather than meetings when feasible	09/20/11 ☑ Applicable ☑ Evaluated ☑ Practical

Implemented? ("N/A" if "Practical" not checked)	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
☑ Fully ☐ Partially ☐ Not Yet ☐ N/A	☐ Cost Increase ☑ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):	Level of Up-Front Investment Included in 5 Year Cost Impact:
☑ Environmental ☑ Economic ☑ Social	☐ Negligible ☐ <$10,000 ☐ $10,001-$50,000 ☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000

Resources Conserved:	☐ BMP Otherwise Required
☑ Hazardous Air Pollutants ☑ Energy ☑ Waste ☑ Criteria Pollutants ☑ Materials ☑ Safety/Community ☑ GHG Emissions ☑ Water ☐ Land Use	If so, required by:

Notes:

All of the meetings for the PDT are done in-house so no additional travel is required. Communication with the other stakeholders is done by either email or phone.

BMP A-7: Incorporate green specifications into solicitations and contracts Examples: • Follow pertinent green procurement policies • Select hotel chains with "green" policies • Select laboratories that utilize renewable energy	09/20/11 ☑ Applicable ☑ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☑ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☑ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☑ Environmental ☑ Economic ☑ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ <$10,000 ☐ $10,001-$50,000 ☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000
Resources Conserved: ☑ Hazardous Air Pollutants ☑ Energy ☑ Waste ☑ Criteria Pollutants ☑ Materials ☑ Safety/Community ☑ GHG Emissions ☑ Water ☑ Land Use	☐ BMP Otherwise Required If so, required by:
Notes: The only contract that the PDT currently has is with the testing lab. It was indicated that the lab is a fairly small enterprise and that the contract was awarded since the lab has 8-A status and it is QSM certified. The PDT indicated that since the lab is a smaller operation it would probably not be capable of implementing larger scale "green" practices.	

BMP A-8: Integrate schedules to allow for resource sharing and fewer days of field mobilization	09/20/11 ☑ Applicable ☑ Evaluated ☑ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☑ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☑ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☑ Environmental ☑ Economic ☑ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ <$10,000 ☐ $10,001-$50,000 ☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000
Resources Conserved: ☑ Hazardous Air Pollutants ☑ Energy ☑ Waste ☑ Criteria Pollutants ☑ Materials ☑ Safety/Community ☑ GHG Emissions ☑ Water ☑ Land Use	☐ BMP Otherwise Required If so, required by:
Notes: The PDT has made efforts to coordinate with the OCRWD2 to share sampling data and the OCRWD2 has offered to allow the PDT to sample wells that were installed near the area that is being investigated. Well installation and soil sampling has proceeded at a much slower rate than expected according to the Project Manager. The drill crew currently mobilizes on Monday, works Tuesday-Thursday, and demobilizes/returns on Fridays. Two different schedules have been discussed to expedite remaining field work including a 10-day on and 4-day off schedule as well as a schedule in which crews would mobilize on Sundays and work Monday-Friday and then return on Saturdays. A limitation exists due to the fact that the landowner lives on site and does not want to have drill crews there during the weekends.	

BMP A-9: Explore multiple site reuse options, including those that include some restriction of site reuse and related resource conservation	09/20/11 ☐ Applicable ☐ Evaluated ☐ Practical

Implemented? ("N/A" if "Practical" not checked):	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
☐ Fully ☐ Partially ☐ Not Yet ☑ N/A	☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ <$10,000 ☐ $10,001-$50,000 ☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000
Resources Conserved: ☐ Hazardous Air Pollutants ☐ Energy ☐ Waste ☐ Criteria Pollutants ☐ Materials ☐ Safety/Community ☐ GHG Emissions ☐ Water ☐ Land Use	☐ BMP Otherwise Required If so, required by:

Notes:

DoD no longer owns the property so the PDT does not have any influence over the site use. The rural water district does plan to develop a well field in the vicinity of the investigation area, so by sharing the data from the SI, USACE is potentially helping the rural water district to utilize the groundwater in the area.

BMP A-10: Conduct thorough review of project documents and historical records to minimize required scope of investigation Examples: • IRP Projects: determine if there are previous aquifer tests that can be used for groundwater modeling rather than conducting new aquifer tests • MMRP Projects: perform careful review of historic documents, aerial photographs, and other existing information to reduce the footprint of land that needs to be disturbed for thorough investigation and remediation • MMRP Projects: use IRP sampling data to supplement and enhance the MMRP field program (if available)	09/20/11 ☑ Applicable ☑ Evaluated ☑ Practical

Implemented? ("N/A" if "Practical" not checked):	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
☑ Fully ☐ Partially ☐ Not Yet ☐ N/A	☐ Cost Increase ☑ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☑ Environmental ☑ Economic ☑ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ <$10,000 ☐ $10,001-$50,000 ☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000
Resources Conserved: ☑ Hazardous Air Pollutants ☑ Energy ☑ Waste ☑ Criteria Pollutants ☑ Materials ☑ Safety/Community ☑ GHG Emissions ☑ Water ☑ Land Use	☐ BMP Otherwise Required If so, required by:

Notes:

The PDT has done a very thorough review of the historical documents for this site and for other Atlas missile sites. The review and research has helped them to optimize multiple aspects of their inspection plan (discussed in BMP B-5).

BMP Category B: Characterization and/or Remedy Approach

BMP B-1: Develop and routinely update a conceptual site model (CSM) to use as a basis for making remedial process decisions	09/20/11 ☑ Applicable ☑ Evaluated ☑ Practical
Implemented? ("N/A" if "Practical" not checked) ☑ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☑ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☑ Environmental ☑ Economic ☑ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ <$10,000 ☐ $10,001-$50,000 ☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000
Resources Conserved: ☑ Hazardous Air Pollutants ☑ Energy ☑ Waste ☑ Criteria Pollutants ☑ Materials ☑ Safety/Community ☑ GHG Emissions ☑ Water ☑ Land Use	☐ BMP Otherwise Required If so, required by:
Notes: A CSM has been developed and will continue to be updated as results from field activities become available.	

BMP B-2: Perform frequent optimization evaluations to improve efficiency of current or planned actions and/or develop alternative remedial approaches that might shorten remedy duration or otherwise improve the net environmental benefit of the remedy	09/20/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☑ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ <$10,000 ☐ $10,001-$50,000 ☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000
Resources Conserved: ☐ Hazardous Air Pollutants ☐ Energy ☐ Waste ☐ Criteria Pollutants ☐ Materials ☐ Safety/Community ☐ GHG Emissions ☐ Water ☐ Land Use	☐ BMP Otherwise Required If so, required by:
Notes: This BMP is not applicable for the current phase that the project is in.	

BMP B-3: Use appropriate characterization or remedy approach based on site conditions

09/20/11

Examples:
- Consider in-situ and passive remedy options that offer adequate protectiveness
- Consider in-situ bioremediation if conditions are already anaerobic and constituents are conducive to reductive dechlorination
- Compare source removal versus in-situ and ex-situ remedial options
- Consider different techniques for impacted areas with higher and lower concentrations
- Use realistic times to remedy closeouts (i.e., estimations through modeling), rather than assumed remedy timeframes (e.g., 30 years) which are often used for evaluation of FS alternatives
- MMRP projects: evaluate man-portable DGM instruments versus vehicle-towed array (VTA) instruments and inclusion of detector-aided reconnaissance (DAR)

☐ Applicable
☐ Evaluated
☐ Practical

Implemented?
("N/A" if "Practical" not checked)

☐ Fully ☐ Partially ☐ Not Yet ☑ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):

☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):

☐ Environmental ☐ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:

☐ Negligible ☐ <$10,000 ☐ $10,001-$50,000
☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000

Resources Conserved:

☐ Hazardous Air Pollutants ☐ Energy ☐ Waste
☐ Criteria Pollutants ☐ Materials ☐ Safety/Community
☐ GHG Emissions ☐ Water ☐ Land Use

☐ BMP Otherwise Required

If so, required by:

Notes:

The Site is not at a level of remedial action which would benefit from this analysis

BMP B-4: Establish decision points to trigger a change from one technology to another or from one remedy alternative to another

09/20/11

Examples:
- Change vapor treatment from thermal oxidation to granular activated carbon (GAC) media based on flow rates and concentrations
- Remove a treatment polishing step if influent to that step already meets discharge criteria
- Move to Monitored Natural Attenuation (MNA) if specific concentration thresholds in groundwater are met

☑ Applicable
☑ Evaluated
☑ Practical

Implemented?
("N/A" if "Practical" not checked)

☐ Fully ☑ Partially ☐ Not Yet ☐ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):

☐ Cost Increase ☑ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):

☑ Environmental ☑ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:

☐ Negligible ☐ <$10,000 ☐ $10,001-$50,000
☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000

Resources Conserved:

☑ Hazardous Air Pollutants ☑ Energy ☑ Waste
☑ Criteria Pollutants ☑ Materials ☑ Safety/Community
☑ GHG Emissions ☑ Water ☐ Land Use

☐ BMP Otherwise Required

If so, required by:

Notes:

The PDT has indicated their desire to switch from low flow sampling to passive diffusion bags as soon as possible (KDHE prefers that a year's worth of low flow samples are taken before changing sampling technology). Currently however, no firm decision point has been set for switching between the two technologies.
Site geology has necessitated changing the drilling methods from cable-tool to mud rotary since there was considerable difficulty with certain "iron-stone" lenses of soil.

BMP B-5: Focus sampling efforts to meet objectives of the specific remedial phase (e.g. sampling during O&M should focus on evaluating remedy performance and not on thorough plume characterization) Examples: • Eliminate sampling parameters as appropriate • Reduce sampling frequency as appropriate • Reduce sample locations as appropriate • Enhance monitoring program as appropriate • MMRP projects: consider Incremental Sampling Methodology (ISM) versus discrete sampling for MC characterization	09/20/11 ☑ Applicable ☑ Evaluated ☑ Practical
Implemented? ("N/A" if "Practical" not checked) ☑ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☑ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☑ Environmental ☑ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ <$10,000 ☐ $10,001-$50,000 ☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000
Resources Conserved: ☑ Hazardous Air Pollutants ☑ Energy ☑ Waste ☑ Criteria Pollutants ☑ Materials ☑ Safety/Community ☑ GHG Emissions ☑ Water ☐ Land Use	☐ BMP Otherwise Required If so, required by:

Notes:

Referring back to BMP A-10, the PDT has used data from other Atlas F sites to convince the regulators that VOCs were the only contaminant that should be tested for (originally KHDE had requested testing for a much larger suite of contaminants).
The number of soil samples that the PDT is collecting is aggressive for the SI stage. They have mentioned that locating the source of contamination at other Atlas F sites has been very difficult so they are trying to close out the soil contamination pathway with the testing results from the SI.
Incremental Sampling Methodology was discussed but it was determined that it is not practical at this site.

BMP B-6: Consider real-time measurements and dynamic work plans to reduce mobilization and improve effectiveness of investigation efforts

09/20/11

☑ Applicable

☑ Evaluated

☑ Practical

Examples:

- Field test kits (e.g., test kits for sulfate)
- Field screening instruments (e.g., x-ray fluorescence for lead or photoionization detectors for volatile organics)
- Drive point sensor technologies (e.g., membrane interface probe [MIP])
- Noting any visual staining or odor which may help to identify contamination
- Establish excavation extent based on real-time data collected as excavation proceeds and use GPS to accurately delineate excavation areas
- MMRP projects: use GPS and/or the same equipment that was used for detection to confirm anomaly signatures prior to excavating
- MMRP projects: consider incorporating field screening methods (e.g., x-ray fluorescence, EXPRAY and explosives test kits, as appropriate or applicable) into the field program to refine sampling locations and reduce the quantities of samples submitted for off-site laboratory analysis

Implemented?
("N/A" if "Practical" not checked)

☑ Fully ☐ Partially ☐ Not Yet ☐ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):

☐ Cost Increase ☑ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):

☑ Environmental ☑ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:

☐ Negligible ☐ <$10,000 ☐ $10,001-$50,000
☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000

Resources Conserved:

☑ Hazardous Air Pollutants ☑ Energy ☑ Waste
☑ Criteria Pollutants ☑ Materials ☑ Safety/Community
☑ GHG Emissions ☑ Water ☑ Land Use

☐ BMP Otherwise Required

If so, required by:

Notes:

Real-time measurements taken with a photoionization detector (PID) have been used with the original goal being to use the findings from the PID to locate two discretionary soil samples. However, the PDT has mentioned that thus far no detects have been recorded by the PID so a different rationale is being used to locate the discretionary soil samples.
The PDT is taking certain groundwater geochemical parameters during low flow sampling (dissolved oxygen, oxidation reduction potential, turbidity) and the GSR team believes that it would be beneficial to test for ferrous iron and nitrate/sulfate so a more complete understanding of the geochemistry can be determined. The PDT would need to weigh the benefits of collecting all of the geochemical parameters at one time versus the desire to limit sampling during the SI phase.

BMP B-7: Consider use of existing site structures/infrastructures or mobilization of temporary structures versus new construction Examples: • Buildings (e.g., for treatment building or field office) • Concrete slabs for foundations • Wells • Existing excavations for storm water control	09/20/11 ☑ Applicable ☑ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☑ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☑ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☑ Environmental ☑ Economic ☑ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ <$10,000 ☐ $10,001-$50,000 ☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000
Resources Conserved: ☐ Hazardous Air Pollutants ☑ Energy ☑ Waste ☐ Criteria Pollutants ☑ Materials ☐ Safety/Community ☐ GHG Emissions ☐ Water ☑ Land Use	☐ BMP Otherwise Required If so, required by:
Notes: The only above ground structure on site is the landowner's residence. No other structures could be utilized, and at this time there is no need for a temporary structure.	

BMP B-8: Establish project-specific decision points to limit extent of remediation Examples: • Project-specific cleanup levels based on a site-specific risk assessment (coordinated with risk assessment experts) rather than generic cleanup levels, if it results in lower footprints for key parameters and is acceptable to all stakeholders • MMRP projects: dig stopping rules and anomaly prioritization/detection criteria to minimize false positives	09/20/11 ☑ Applicable ☑ Evaluated ☑ Practical
Implemented? ("N/A" if "Practical" not checked) ☑ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☑ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☑ Environmental ☑ Economic ☑ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ <$10,000 ☐ $10,001-$50,000 ☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000
Resources Conserved: ☑ Hazardous Air Pollutants ☑ Energy ☑ Waste ☑ Criteria Pollutants ☑ Materials ☑ Safety/Community ☑ GHG Emissions ☑ Water ☑ Land Use	☐ BMP Otherwise Required If so, required by:
Notes: The PDT has identified the KDHE Tier 2 risk levels as the site-specific standard for soil contamination, and the USEPA MCLs for groundwater are being used to characterize any potential groundwater contamination.	

BMP B-9: Consider leaving in place structures whose removal is not necessary (i.e. foundations, underground pillars, etc.)	09/20/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☑ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ <$10,000 ☐ $10,001-$50,000 ☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000
Resources Conserved: ☐ Hazardous Air Pollutants ☐ Energy ☐ Waste ☐ Criteria Pollutants ☐ Materials ☐ Safety/Community ☐ GHG Emissions ☐ Water ☐ Land Use	☐ BMP Otherwise Required If so, required by:

Notes:

As previously stated, DoD does not own the site, so no modification of the structures is possible. In addition, a CON/HTRW project for this site has already been closed.

BMP C-1: Reduce the number of trips for personnel Examples: • Encourage carpooling • Use telemetry systems and webcams to remotely transmit data directly to project offices to avoid trips	09/20/11 ☑ Applicable ☑ Evaluated ☑ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☑ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☑ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☑ Environmental ☑ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ <$10,000 ☐ $10,001-$50,000 ☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000
Resources Conserved: ☑ Hazardous Air Pollutants ☑ Energy ☐ Waste ☑ Criteria Pollutants ☐ Materials ☑ Safety/Community ☑ GHG Emissions ☐ Water ☐ Land Use	☐ BMP Otherwise Required If so, required by:

Notes:

The number of mob/demob trips could be reduced by switching drilling schedules to allow for more extended mobilization time periods as discussed in BMP A-8.
It is unlikely that telemetry systems would be used for sampling since field crews would have to mobilize to collect and ship VOC samples. Water level sampling, which is a potential use of telemetry systems, could simply be done when crews mobilize for VOC sample collection.

BMP C-2: Reduce the number of trips and/or volume of transported materials, equipment, or waste Examples: • Transfer full loads by consolidating shipments from vendors and/or shipments to disposal sites (also share shipments with neighbors if feasible) • Purchase more concentrated chemicals to reduce transportation weight and/or volume	09/20/11 ☑ Applicable ☑ Evaluated ☑ Practical
Implemented? ("N/A" if "Practical" not checked) ☑ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☑ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☑ Environmental ☑ Economic ☑ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ <$10,000 ☐ $10,001-$50,000 ☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000
Resources Conserved: ☑ Hazardous Air Pollutants ☑ Energy ☐ Waste ☑ Criteria Pollutants ☐ Materials ☑ Safety/Community ☑ GHG Emissions ☐ Water ☐ Land Use	☐ BMP Otherwise Required If so, required by:

Notes:

The drill rigs are left on site for the duration of the drilling so there are no weekend return trips. The PDT is allowing all of the liquid IDW to sit in a 1000 gallon tank and it is expected that they will be able to dispose of this on the ground, eliminating the need for transportation of the IDW to a designated disposal area. The PDT also believes that they will be able to get KDHE to allow them to dispose of drill cuttings on site.

BMP C-3: Reduce trip lengths

09/20/11

[x] Applicable [x] Evaluated [x] Practical

Examples

- Dispose of waste at closest appropriate facility
- Purchase materials, equipments, and services from local vendors
- Use locally produced supplies
- Select most efficient transportation route

Implemented?
("N/A" if "Practical" not checked)

[ ] Fully [x] Partially [ ] Not Yet [ ] N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):

[ ] Cost Increase [x] Cost Savings [ ] Cost Neutral [ ] N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):

[x] Environmental [x] Economic [x] Social

Level of Up-Front Investment Included in 5 Year Cost Impact:

[ ] Negligible [ ] <$10,000 [ ] $10,001-$50,000
[ ] $50,001-$100,000 [ ] $100,001-$500,000 [ ] >$500,000

Resources Conserved:

[x] Hazardous Air Pollutants [x] Energy [ ] Waste
[x] Criteria Pollutants [ ] Materials [x] Safety/Community
[x] GHG Emissions [ ] Water [ ] Land Use

[ ] BMP Otherwise Required

If so, required by:

Notes:

Field crews are staying in local motels and it is assumed that crews use the most efficient routes when planning trips.
The lab that receives all of the field samples is located nearly 1000 miles from the Site. While there probably are closer labs, the decision to use this particular lab was made based on other factors (see BMP A-7).

BMP C-4: Use alternate fuels or other options for transportation when possible

09/20/11

[x] Applicable [ ] Evaluated [ ] Practical

Examples:

- Compressed natural gas
- Biodiesel blends
- Ethanol blends
- Hybrid and/or electric
- Rail lines versus trucks
- Use a fuel efficient passenger car rather than a pickup truck if task allows

Implemented?
("N/A" if "Practical" not checked)

[ ] Fully [ ] Partially [ ] Not Yet [x] N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):

[x] Cost Increase [ ] Cost Savings [ ] Cost Neutral [ ] N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):

[x] Environmental [x] Economic [x] Social

Level of Up-Front Investment Included in 5 Year Cost Impact:

[ ] Negligible [x] <$10,000 [ ] $10,001-$50,000
[ ] $50,001-$100,000 [ ] $100,001-$500,000 [ ] >$500,000

Resources Conserved:

[ ] Hazardous Air Pollutants [x] Energy [ ] Waste
[ ] Criteria Pollutants [x] Materials [ ] Safety/Community
[ ] GHG Emissions [ ] Water [ ] Land Use

[ ] BMP Otherwise Required

If so, required by:

Notes:

During the Step 5 call, the PDT indicated that they do not have control over which fuels the drill crews use in their equipment. They did agree to ask the drill crews if there were any alternate fuels used. In addition, the PDT stated that alternate fuels are not very abundant in Kansas.

BMP D-1: Consider and implement approaches to minimize engine idle times	09/20/11 ☑ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☑ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☑ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☑ Environmental ☑ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ <$10,000 ☐ $10,001-$50,000 ☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000
Resources Conserved: ☑ Hazardous Air Pollutants ☑ Energy ☐ Waste ☑ Criteria Pollutants ☐ Materials ☐ Safety/Community ☑ GHG Emissions ☐ Water ☐ Land Use	☐ BMP Otherwise Required If so, required by:

Notes:

The PDT will ask the drill crews if any specific procedures are used to minimize engine idling. Members of the PDT stated that the age of the equipment may be a factor in engine idling since older drill rigs may not be as easy to start multiple times in a day,opposite to that point is the desire to not leave the equipment on longer than necessary during the hot days to avoid engine overheating.
It is not believed that the crews leave their drill rigs on during extended periods of inactivity (such as during lunch times).

BMP D-2: Ensure peak operating efficiency of equipment to reduce energy use and emissions Examples • Perform preventative maintenance and operate equipment per manufacturer instructions • Perform retrofits involving low-maintenance multi-stage filters for cleaner engine exhaust • Use synthetic oil to extend operating life (and reduce waste oil) • Purchase new equipment with reduced emissions	09/20/11 ☑ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☑ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☑ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☑ Environmental ☑ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ <$10,000 ☐ $10,001-$50,000 ☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000
Resources Conserved: ☑ Hazardous Air Pollutants ☑ Energy ☐ Waste ☑ Criteria Pollutants ☐ Materials ☐ Safety/Community ☑ GHG Emissions ☐ Water ☐ Land Use	☐ BMP Otherwise Required If so, required by:

Notes:

As is the case with other drilling activities, the PDT does not have control over the driller's procedures. However, the PDT will ask the drill crew if there are any procedures for equipment maintenance and if there are any low-sulfur fuels that can be used in the equipment.

BMP D-3: Use alternate fuel options for equipment when possible Examples: • Compressed natural gas • Biodiesel • Ethanol blends • Ultra-low sulfur diesel, wherever available (and as required by engines with PM traps)	09/20/11 ☑ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☑ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☑ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☑ Environmental ☑ Economic ☑ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☑ <$10,000 ☐ $10,001-$50,000 ☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000
Resources Conserved: ☑ Hazardous Air Pollutants ☑ Energy ☐ Waste ☑ Criteria Pollutants ☐ Materials ☐ Safety/Community ☑ GHG Emissions ☐ Water ☐ Land Use	☐ BMP Otherwise Required If so, required by:
Notes: See BMP C4.	

BMP D-4: Select appropriate equipment and/or power sources for the job Examples: • Avoid using large excavators for small earthmoving projects • Use direct push methods when possible to reduce drilling duration • Compare potential use of electricity versus battery versus generator	09/20/11 ☑ Applicable ☑ Evaluated ☑ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☑ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☑ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☑ Environmental ☑ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ <$10,000 ☐ $10,001-$50,000 ☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000
Resources Conserved: ☑ Hazardous Air Pollutants ☑ Energy ☑ Waste ☑ Criteria Pollutants ☑ Materials ☐ Safety/Community ☑ GHG Emissions ☑ Water ☐ Land Use	☐ BMP Otherwise Required If so, required by:
Notes: Drill rig selection was determined by the goal of using in-house drill crews as well as the geology of the Site. While in-house drill crews do not have access to the "greener" drilling methods such as direct push or sonic drilling, the difficult geology of the site would have excluded direct push from consideration. If more wells are to be installed in the future, the PDT may want to consider the benefits versus costs of using sonic drilling.	

BMP D-5: Use variable frequency drives on motors (e.g. pumps, blowers) or replace oversized motors with properly sized motors	09/20/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☑ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ <$10,000 ☐ $10,001-$50,000 ☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000
Resources Conserved: ☐ Hazardous Air Pollutants ☐ Energy ☐ Waste ☐ Criteria Pollutants ☐ Materials ☐ Safety/Community ☐ GHG Emissions ☐ Water ☐ Land Use	☐ BMP Otherwise Required If so, required by:
Notes: This BMP is not applicable during the SI phase since there are no pumps or blowers (other than the bladder pumps, which would not benefit from VFDs).	

BMP D-6: Identify options for generating renewable energy for direct use in the remedy and/or for alternate use at or near the project site Examples: • Solar, wind, landfill gas (microturbines), combined heat and power, geothermal heat exchange • Applications for remote areas such as solar pumps or solar flares (if demand is not continuous, the need for a battery backup may be avoided) • Generate power or heat exchange from water to be discharged	09/20/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☑ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ <$10,000 ☐ $10,001-$50,000 ☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000
Resources Conserved: ☐ Hazardous Air Pollutants ☐ Energy ☐ Waste ☐ Criteria Pollutants ☐ Materials ☐ Safety/Community ☐ GHG Emissions ☐ Water ☐ Land Use	☐ BMP Otherwise Required If so, required by:
Notes: This BMP is not applicable for multiple reasons. First, it is too early to know if the project will even proceed to a level where it would be necessary or beneficial to produce renewable energy on-site. Second, since the land is not owned by the DoD, there is an issue with making any kind of permanent improvements to the Site such as adding solar panels or wind turbines.	

BMP D-7: Consider purchase of renewable energy certificates to offset emissions from the remedial activities	09/20/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☑ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ <$10,000 ☐ $10,001-$50,000 ☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000
Resources Conserved: ☐ Hazardous Air Pollutants ☐ Energy ☐ Waste ☐ Criteria Pollutants ☐ Materials ☐ Safety/Community ☐ GHG Emissions ☐ Water ☐ Land Use	☐ BMP Otherwise Required If so, required by:
Notes: Purchasing any sort of renewable energy certificates or carbon credits is hindered by the necessity of keeping cost at a minimum.	

BMP D-8: Design/modify housing required for above-ground treatment components for energy efficiency Examples • Passive lighting • Compact fluorescent lighting (CFL) or light-emitting diode (LED) lighting • Timers and/or motion control sensors for lighting • Shading • Minimize heating and cooling needs (building size, insulation, etc.)	09/20/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☑ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ <$10,000 ☐ $10,001-$50,000 ☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000
Resources Conserved: ☐ Hazardous Air Pollutants ☐ Energy ☐ Waste ☐ Criteria Pollutants ☐ Materials ☐ Safety/Community ☐ GHG Emissions ☐ Water ☐ Land Use	☐ BMP Otherwise Required If so, required by:
Notes: No housing is available for re-purposing or modifying. Also at the SI level of the cleanup process, there is no need for any sort of structures to house treatment equipment.	

BMP D-9: For remedies that involve groundwater or air extraction, optimize extraction to reduce flow rates (potentially beneficial with respect to energy use, materials usage, water resources, waste disposal, etc.)

09/20/11

☐ Applicable
☐ Evaluated
☐ Practical

Implemented?
("N/A" if "Practical" not checked)

☐ Fully ☐ Partially ☐ Not Yet ☑ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):

☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):

☐ Environmental ☐ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:

☐ Negligible ☐ <$10,000 ☐ $10,001-$50,000
☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000

Resources Conserved:

☐ Hazardous Air Pollutants ☐ Energy ☐ Waste
☐ Criteria Pollutants ☐ Materials ☐ Safety/Community
☐ GHG Emissions ☐ Water ☐ Land Use

☐ BMP Otherwise Required

If so, required by:

Notes:

As stated before, this BMP is not applicable for an SI.

BMP D-10: Consider pulsing for extraction of water or air to maximize mass removal per unit of time or energy by extracting higher concentrations

09/20/11

☐ Applicable
☐ Evaluated
☐ Practical

Implemented?
("N/A" if "Practical" not checked)

☐ Fully ☐ Partially ☐ Not Yet ☑ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting
(discuss in notes if necessary):

☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):

☐ Environmental ☐ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:

☐ Negligible ☐ <$10,000 ☐ $10,001-$50,000
☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000

Resources Conserved:

☐ Hazardous Air Pollutants ☐ Energy ☐ Waste
☐ Criteria Pollutants ☐ Materials ☐ Safety/Community
☐ GHG Emissions ☐ Water ☐ Land Use

☐ BMP Otherwise Required

If so, required by:

Notes:

Similar to BMP B-9.

BMP D-11: Run electrical equipment during times of lower electrical demand if possible (this does not reduce energy use but could lower cost and also can lower stress on the energy grid during periods of peak demand)	09/20/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☑ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ <$10,000 ☐ $10,001-$50,000 ☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000
Resources Conserved: ☐ Hazardous Air Pollutants ☐ Energy ☐ Waste ☐ Criteria Pollutants ☐ Materials ☐ Safety/Community ☐ GHG Emissions ☐ Water ☐ Land Use	☐ BMP Otherwise Required If so, required by:
Notes: No electrical equipment is used for extended periods.	

BMP E-1: Use materials that have been recycled Examples: • Steel • Asphalt • Plastics • Concrete	09/20/11 ☑ Applicable ☑ Evaluated ☑ Practical
Implemented? ("N/A" if "Practical" not checked) ☑ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☑ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☑ Environmental ☑ Economic ☑ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ <$10,000 ☐ $10,001-$50,000 ☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000
Resources Conserved: ☐ Hazardous Air Pollutants ☐ Energy ☑ Waste ☐ Criteria Pollutants ☑ Materials ☐ Safety/Community ☐ GHG Emissions ☐ Water ☐ Land Use	☐ BMP Otherwise Required If so, required by:
Notes: The PDT is recycling the bladder pumps (with new bladders installed) that were used for low flow sampling at another site. They are also recycling a polyethylene tank to store all IDW on site and all of the sample coolers used for shipping to the lab are reused several times.	

BMP E-2: Optimize the amount of materials used Examples: • Experiment with different material amounts/doses • Consider alternate materials • Use timers or feedback loops and process controls for dosing • MMRP projects: minimize quantities of donor explosives for MEC destruction	09/20/11 ☑ Applicable ☑ Evaluated ☑ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☑ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☑ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☑ Environmental ☑ Economic ☑ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ <$10,000 ☐ $10,001-$50,000 ☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000
Resources Conserved: ☐ Hazardous Air Pollutants ☐ Energy ☑ Waste ☐ Criteria Pollutants ☑ Materials ☐ Safety/Community ☐ GHG Emissions ☐ Water ☐ Land Use	☐ BMP Otherwise Required If so, required by:
Notes: The PDT stated that in order to satisfy sample holding time requirements, they have been forced to send half filled sample containers due to setbacks with the drilling crews. Normal practices are to send full containers. There are no other significant material uses that could be optimized.	

BMP E-3: Utilize less refined materials when feasible Examples: • Limestone instead of sodium hydroxide for pH adjustment • Native fill instead of select fill	09/20/11 ☑ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☑ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ <$10,000 ☐ $10,001-$50,000 ☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000
Resources Conserved: ☐ Hazardous Air Pollutants ☐ Energy ☐ Waste ☐ Criteria Pollutants ☐ Materials ☐ Safety/Community ☐ GHG Emissions ☐ Water ☐ Land Use	☐ BMP Otherwise Required If so, required by:
Notes: The only activity that uses a significant amount of material is monitoring well installation and both the PDT and the GSR team agree that using recycled materials is not practical.	

BMP E-4: Identify opportunities for using by-products or "waste" materials from local sources in place of refined chemicals or materials Examples: • Cheese whey, molasses, compost, or off-spec food products for inducing anaerobic conditions • Crushed concrete for use as fill • Concrete from coal combustion byproducts	09/20/11 ☑ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ <$10,000 ☐ $10,001-$50,000 ☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000
Resources Conserved: ☐ Hazardous Air Pollutants ☐ Energy ☐ Waste ☐ Criteria Pollutants ☐ Materials ☐ Safety/Community ☐ GHG Emissions ☐ Water ☐ Land Use	☐ BMP Otherwise Required If so, required by:
Notes: Similar to BMP E-3.	

BMP E-5: Reduce demand on Publicly Owned Treatment Works (POTWs) Examples • Discharge treated water to groundwater or to surface water rather than POTW • Minimize amount of water requiring treatment	09/20/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☑ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ <$10,000 ☐ $10,001-$50,000 ☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000
Resources Conserved: ☐ Hazardous Air Pollutants ☐ Energy ☐ Waste ☐ Criteria Pollutants ☐ Materials ☐ Safety/Community ☐ GHG Emissions ☐ Water ☐ Land Use	☐ BMP Otherwise Required If so, required by:

Notes:

Since the Site is several miles away from any public treatment infrastructure, it is not possible for Site activities to have an impact on POTWs. Furthermore, the PDT believes that they will be able to return all of the IDW back to the Site by spreading drill cuttings on the ground and dumping liquid IDW at a location that will allow for it to percolate back into the aquifer.

BMP F-1: Minimize water consumption	09/20/11
Examples: • Sensors to turn off water when not needed • Low flow fittings • Minimize water needs for irrigation (landscape choices, use of mats and mulch)	☑ Applicable ☑ Evaluated ☑ Practical

Implemented? ("N/A" if "Practical" not checked)	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
☐ Fully ☐ Partially ☑ Not Yet ☐ N/A	☐ Cost Increase ☑ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):	Level of Up-Front Investment Included in 5 Year Cost Impact:
☑ Environmental ☑ Economic ☑ Social	☐ Negligible ☐ <$10,000 ☐ $10,001-$50,000 ☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000

Resources Conserved:	☐ BMP Otherwise Required
☐ Hazardous Air Pollutants ☐ Energy ☐ Waste ☐ Criteria Pollutants ☐ Materials ☐ Safety/Community ☐ GHG Emissions ☑ Water ☐ Land Use	If so, required by:

Notes:

As discussed in BMP B-4, the PDT expects to change sampling technology from low flow to passive diffusion bags once KDHE believes that enough low flow sampling has been done.
The drillers eventually switched from the initial drilling technology of cable tool to mud rotary due to problems encountered using cable tool drilling. This represents an increase in water consumption.

BMP F-2: Preferentially use less refined water resources when feasible	09/20/11
Examples: • Use extracted groundwater instead of potable water for chemical blending • Capture and store rain/storm water for future use • Employ rumble grates with a closed-loop gray-water washing system	☑ Applicable ☐ Evaluated ☐ Practical

Implemented? ("N/A" if "Practical" not checked)	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
☐ Fully ☐ Partially ☐ Not Yet ☑ N/A	☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):	Level of Up-Front Investment Included in 5 Year Cost Impact:
☐ Environmental ☐ Economic ☐ Social	☐ Negligible ☐ <$10,000 ☐ $10,001-$50,000 ☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000

Resources Conserved:	☐ BMP Otherwise Required
☐ Hazardous Air Pollutants ☐ Energy ☐ Waste ☐ Criteria Pollutants ☐ Materials ☐ Safety/Community ☐ GHG Emissions ☐ Water ☐ Land Use	If so, required by:

Notes:

The only activity that requires any water consumption is drilling (water for mud preparation and for equipment decontamination). There are no nearby streams, so the PDT would need to coordinate with either the landowner or the rural water district to obtain water. This coordination to obtain water may represent too great of an effort for it to be worthwhile.

BMP F-3: Use extracted and treated water for beneficial purposes Examples: • Irrigation • Potable water • Industrial process water	09/20/11 [ ] Applicable [ ] Evaluated [ ] Practical
Implemented? ("N/A" if "Practical" not checked) [ ] Fully [ ] Partially [ ] Not Yet [x] N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): [ ] Cost Increase [ ] Cost Savings [ ] Cost Neutral [ ] N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): [ ] Environmental [ ] Economic [ ] Social	Level of Up-Front Investment Included in 5 Year Cost Impact: [ ] Negligible [ ] <$10,000 [ ] $10,001-$50,000 [ ] $50,001-$100,000 [ ] $100,001-$500,000 [ ] >$500,000
Resources Conserved: [ ] Hazardous Air Pollutants [ ] Energy [ ] Waste [ ] Criteria Pollutants [ ] Materials [ ] Safety/Community [ ] GHG Emissions [ ] Water [ ] Land Use	[ ] BMP Otherwise Required If so, required by:

Notes:

There is no significant amount of extracted and treated water. If testing shows that there is an acceptably low level of contamination, any water that the PDT collects during well installation and development will be returned to the aquifer, which is addressed in BMP F-4.

BMP F-4: Promote groundwater recharge Examples: • Recharge extracted and treated water when beneficial uses of the water are not identified and reinjection is practical • Minimize site area covered by impervious surfaces to reduce runoff and maximize infiltration (unless such capping is a specific component of the remedial action)	09/20/11 [x] Applicable [x] Evaluated [x] Practical
Implemented? ("N/A" if "Practical" not checked) [ ] Fully [ ] Partially [x] Not Yet [ ] N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): [ ] Cost Increase [ ] Cost Savings [x] Cost Neutral [ ] N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): [x] Environmental [x] Economic [x] Social	Level of Up-Front Investment Included in 5 Year Cost Impact: [ ] Negligible [ ] <$10,000 [ ] $10,001-$50,000 [ ] $50,001-$100,000 [ ] $100,001-$500,000 [ ] >$500,000
Resources Conserved: [ ] Hazardous Air Pollutants [ ] Energy [ ] Waste [ ] Criteria Pollutants [ ] Materials [ ] Safety/Community [ ] GHG Emissions [x] Water [ ] Land Use	[ ] BMP Otherwise Required If so, required by:

Notes:

The PDT believes that levels of contamination in the liquid IDW will be low enough for KDHE to allow them to return the groundwater to the aquifer it is taken from. The PDT should coordinate with the landowner to determine both where they can place the liquid IDW and what is the maximum amount of IDW that the landowner is comfortable with them disposing.

BMP F-5: Maintain water quality by preventing nutrient loading to surface water or groundwater Examples: • Use phosphate-free detergents instead of organic solvents or acids to decontaminate sampling equipment (if not required for some contaminants)	09/20/11 ☑ Applicable ☑ Evaluated ☑ Practical
Implemented? ("N/A" if "Practical" not checked) ☑ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☑ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☑ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ <$10,000 ☐ $10,001-$50,000 ☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000
Resources Conserved: ☐ Hazardous Air Pollutants ☐ Energy ☐ Waste ☐ Criteria Pollutants ☐ Materials ☐ Safety/Community ☐ GHG Emissions ☑ Water ☐ Land Use	☐ BMP Otherwise Required If so, required by:
Notes: The PDT uses phosphate free detergents for equipment decontamination.	

BMP G-1: Minimize drill cuttings and all other investigation derived waste (including personal protection equipment)

Examples:

- Direct push or sonic drilling to reduce drill cuttings
- Low-flow sampling or passive diffusion bags (if applicable) to reduce purge water

09/20/11

☑ Applicable ☑ Evaluated ☑ Practical

Implemented? ("N/A" if "Practical" not checked)

☐ Fully ☐ Partially ☑ Not Yet ☐ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):

☐ Cost Increase ☑ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):

☑ Environmental ☑ Economic ☑ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:

☐ Negligible ☐ <$10,000 ☐ $10,001-$50,000 ☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000

Resources Conserved:

☑ Hazardous Air Pollutants ☑ Energy ☑ Waste
☑ Criteria Pollutants ☑ Materials ☑ Safety/Community
☑ GHG Emissions ☑ Water ☐ Land Use

☐ BMP Otherwise Required

If so, required by:

Notes:

Applications of this BMP have been discussed in several other BMPs including B-4 and F-1 for low-flow vs. passive diffusion bags and D-4 and F-1 for drilling technology selection. While low-flow sampling does not use a tremendous amount of water, it does use more than passive diffusion bags. Also, mud rotary drilling generates a significantly larger amount of waste than any other drilling method.

BMP G-2: Segregate excavated soil in pre-planned staging areas so that "clean material" can be deposited on-site and/or reused rather than transported for off-site disposal

09/20/11

☑ Applicable ☑ Evaluated ☐ Practical

Implemented? ("N/A" if "Practical" not checked)

☐ Fully ☐ Partially ☐ Not Yet ☑ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):

☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):

☑ Environmental ☑ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:

☐ Negligible ☐ <$10,000 ☐ $10,001-$50,000 ☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000

Resources Conserved:

☑ Hazardous Air Pollutants ☑ Energy ☑ Waste
☑ Criteria Pollutants ☑ Materials ☐ Safety/Community
☑ GHG Emissions ☐ Water ☐ Land Use

☐ BMP Otherwise Required

If so, required by:

Notes:

Drill cuttings are stored in 55 gallon drums so there is already some amount of segregation occurring although segregation of drill cuttings is not the intended purpose of this action, it is merely a by-product. Larger and more involved processes for segregating drill cuttings are unnecessary due to the limited amount of cuttings (approximately 1-2 barrels from each boring).

BMP G-3: Consider on-site treatment and reuse of soil instead of off-site disposal Examples: • Land farming • Above ground soil vapor extraction (SVE)	09/20/11 ☑ Applicable ☑ Evaluated ☑ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☑ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☑ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ <$10,000 ☐ $10,001-$50,000 ☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000
Resources Conserved: ☑ Hazardous Air Pollutants ☑ Energy ☑ Waste ☑ Criteria Pollutants ☐ Materials ☑ Safety/Community ☑ GHG Emissions ☐ Water ☐ Land Use	☐ BMP Otherwise Required If so, required by:
Notes: The PDT stated that they may bring in a portable GAC unit if disposal of IDW on site is not permitted due to unacceptable levels of contamination. Land farming of drill cuttings to allow for passive volatilization of any VOCs may be allowed by the regulators according to the Project Manager.	

BMP G-4: Minimize need to transport and dispose hazardous waste Examples: • Consider delisting listed hazardous waste if waste is not characteristically hazardous waste • Segregate hazardous waste and non-hazardous waste	09/20/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☑ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ <$10,000 ☐ $10,001-$50,000 ☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000
Resources Conserved: ☐ Hazardous Air Pollutants ☐ Energy ☐ Waste ☐ Criteria Pollutants ☐ Materials ☐ Safety/Community ☐ GHG Emissions ☐ Water ☐ Land Use	☐ BMP Otherwise Required If so, required by:
Notes: As discussed in BMPs G-1 through G-3, the only wastes generated on site are due to drilling. The PDT does not believe that they will need to dispose of drill cuttings off site since VOC levels should be below the acceptable risk levels. Furthermore, it is not expected that any IDW will have contamination high enough for it to classify as hazardous.	

BMP G-5: When possible, avoid/minimize use of hazardous/toxic materials that may require special handling or disposal

Examples:

- Cleaning solutions
- Pesticides
- Disposable batteries (use rechargeable batteries)
- MMRP projects: minimize Chemical Agent Contaminated Media (CACM) at RCWM

09/20/11

☑ Applicable ☑ Evaluated ☑ Practical

Implemented? ("N/A" if "Practical" not checked)

☑ Fully ☐ Partially ☐ Not Yet ☐ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):

☐ Cost Increase ☑ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):

☑ Environmental ☑ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:

☐ Negligible ☐ <$10,000 ☐ $10,001-$50,000 ☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000

Resources Conserved:

☐ Hazardous Air Pollutants ☐ Energy ☐ Waste ☐ Criteria Pollutants ☐ Materials ☑ Safety/Community ☐ GHG Emissions ☐ Water ☐ Land Use

☐ BMP Otherwise Required

If so, required by:

Notes:

As standard operating procedures, the PDT uses pre-preserved sampling containers and does not perform any solvent rinses during equipment decontamination. No hazardous wastes are used.

BMP G-6: Recycle or reuse materials rather than disposing of them

Examples:

- Cardboard, Plastics, Concrete, Asphalt
- Steel and other metals
- Recovered oil/product
- Mulch/compost
- MMRP projects: recycle recovered Material Documented as Safe (MDAS) after inspection and certification that the remnants are free of explosive hazard

09/20/11

☑ Applicable ☑ Evaluated ☑ Practical

Implemented? ("N/A" if "Practical" not checked)

☐ Fully ☑ Partially ☐ Not Yet ☐ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):

☐ Cost Increase ☐ Cost Savings ☑ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):

☑ Environmental ☐ Economic ☑ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:

☐ Negligible ☐ <$10,000 ☐ $10,001-$50,000 ☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000

Resources Conserved:

☐ Hazardous Air Pollutants ☐ Energy ☑ Waste ☐ Criteria Pollutants ☑ Materials ☐ Safety/Community ☐ GHG Emissions ☐ Water ☐ Land Use

☐ BMP Otherwise Required

If so, required by:

Notes:

Since the Site is not owned by DoD, all disposables are taken off site. The PDT did not mentioned any practices for recycling materials.

The PDT may want to consider bringing containers for segregating recyclable materials and disposables so that once wastes are taken off-site they can be properly disposed. As stated in BMP E-1, the PDT is recycling pumps and IDW containers.

BMP H-1: Minimize erosion and soil transport to surface water bodies Examples: • Quickly restore any vegetated areas disrupted by equipment or vehicles • Institute appropriate erosion controls during excavation such as silt fencing	09/20/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☑ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ <$10,000 ☐ $10,001-$50,000 ☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000
Resources Conserved: ☐ Hazardous Air Pollutants ☐ Energy ☐ Waste ☐ Criteria Pollutants ☐ Materials ☐ Safety/Community ☐ GHG Emissions ☐ Water ☐ Land Use	☐ BMP Otherwise Required If so, required by:
Notes: There are no activities such as excavating, grading, or stripping of topsoil that would cause erosion.	

BMP H-2: Minimize disturbances to land Examples: • Establish well-defined traffic patterns for onsite activities to minimize disturbed areas • Consider non-intrusive investigation techniques (e.g., geophysical methods) to identify items like UST's and buried drums	09/20/11 ☑ Applicable ☑ Evaluated ☑ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☑ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☑ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☑ Environmental ☐ Economic ☑ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ <$10,000 ☐ $10,001-$50,000 ☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000
Resources Conserved: ☐ Hazardous Air Pollutants ☐ Energy ☐ Waste ☐ Criteria Pollutants ☐ Materials ☑ Safety/Community ☐ GHG Emissions ☐ Water ☑ Land Use	☐ BMP Otherwise Required If so, required by:
Notes: Following a heavy rainstorm, some ruts were made on the land by drill rigs. The PDT indicated that in the future they will try to do a thorough job of educating the landowner on the field activities that will occur and potential impacts that may happen. The PDT may want to consider providing field crews with maps or illustrations showing where they should and should not drive vehicles.	

BMP H-3: Preserve/restore ecosystems to the extent possible

Examples:

- Limit the removal of trees and vegetation
- Attempt to transplant disturbed shrubs and small trees to other locations
- Use native species for re-vegetation
- Retrieve dead trees during excavation and later reposition them as habitat snags
- Select and place suitably sized and typed stones into water beds and banks
- Undercut surface water banks in ways that mirror natural conditions
- Cut back rather than remove trees, bushes, vegetation

09/20/11

☐ Applicable ☐ Evaluated ☐ Practical

Implemented? ("N/A" if "Practical" not checked)

☐ Fully ☐ Partially ☐ Not Yet ☑ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):

☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):

☑ Environmental ☐ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:

☐ Negligible ☐ <$10,000 ☐ $10,001-$50,000 ☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000

Resources Conserved:

☐ Hazardous Air Pollutants ☐ Energy ☐ Waste
☐ Criteria Pollutants ☐ Materials ☐ Safety/Community
☐ GHG Emissions ☐ Water ☐ Land Use

☐ BMP Otherwise Required

If so, required by:

Notes:

This BMP is applicable in a general sense for the SI process, but due to the fact that the PDT did not state that any land needs to be cleared it is not specifically applicable at this Site.

BMP H-4: Minimize drawdown of the water table in sensitive areas such as wetlands or areas subject to subsidence

09/20/11

☐ Applicable ☐ Evaluated ☐ Practical

Implemented? ("N/A" if "Practical" not checked)

☐ Fully ☐ Partially ☐ Not Yet ☑ N/A

Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):

☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A

GSR Parameter Categories Addressed by the BMP for this Project (check all that apply):

☐ Environmental ☐ Economic ☐ Social

Level of Up-Front Investment Included in 5 Year Cost Impact:

☐ Negligible ☐ <$10,000 ☐ $10,001-$50,000 ☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000

Resources Conserved:

☐ Hazardous Air Pollutants ☐ Energy ☐ Waste
☐ Criteria Pollutants ☐ Materials ☐ Safety/Community
☐ GHG Emissions ☐ Water ☐ Land Use

☐ BMP Otherwise Required

If so, required by:

Notes:

Similar to BMP H-3, there is no significant water use that would make this applicable for the Site.

BMP H-5: Construct wells and other remedial process infrastructure (piping, buildings, etc.) to minimize restriction to anticipated future use of the site	09/20/11 ☑ Applicable ☑ Evaluated ☑ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☑ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☑ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☑ Environmental ☑ Economic ☑ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ <$10,000 ☐ $10,001-$50,000 ☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000
Resources Conserved: ☐ Hazardous Air Pollutants ☐ Energy ☐ Waste ☐ Criteria Pollutants ☑ Materials ☐ Safety/Community ☐ GHG Emissions ☐ Water ☐ Land Use	☐ BMP Otherwise Required If so, required by:

Notes:

The PDT indicated that the landowner uses an existing 2" monitoring well for water supply. While there are no explicit considerations made for made for reusing the monitoring wells as water supply wells, they may be beneficially reused by the landowner.
The PDT also completed the necessary applications with KDHE to install flush mounts instead of monuments for the monitoring wells. This provides the esthetic benefit of not having casings and poles stick up above ground and it also requires less materials.

BMP H-6: Preserve/restore cultural resources to the extent possible Examples: • Protected lands such as wildlife refuges, national parks, and wilderness areas • Culturally sensitive sites such as cemeteries, native burials, and archaeological finds • Buildings or land parcels with historical significance	09/20/11 ☑ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☑ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☑ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ <$10,000 ☐ $10,001-$50,000 ☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000
Resources Conserved: ☐ Hazardous Air Pollutants ☐ Energy ☐ Waste ☐ Criteria Pollutants ☐ Materials ☑ Safety/Community ☐ GHG Emissions ☐ Water ☑ Land Use	☐ BMP Otherwise Required If so, required by:

Notes:

A Preliminary Assessment (PA) that was previously completed showed that there were no sensitive cultural resources that would be endangered by activities at the Site.

BMP I-1: Minimize and mitigate noise, light, and odor disturbance during all phases of the remedial process, to the extent practicable	09/20/11 [x] Applicable [x] Evaluated [x] Practical
Implemented? ("N/A" if "Practical" not checked) [x] Fully [ ] Partially [ ] Not Yet [ ] N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): [ ] Cost Increase [ ] Cost Savings [x] Cost Neutral [ ] N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): [ ] Environmental [ ] Economic [x] Social	Level of Up-Front Investment Included in 5 Year Cost Impact: [ ] Negligible [ ] <$10,000 [ ] $10,001-$50,000 [ ] $50,001-$100,000 [ ] $100,001-$500,000 [ ] >$500,000
Resources Conserved: [ ] Hazardous Air Pollutants [ ] Energy [ ] Waste [ ] Criteria Pollutants [ ] Materials [x] Safety/Community [ ] GHG Emissions [ ] Water [ ] Land Use	[ ] BMP Otherwise Required If so, required by:
Notes: The PDT indicated that they are not working on the weekends in order to avoid disturbing the landowner when they are home.	

BMP I-2: Minimize dust during construction activities by spraying water or techniques such as laying biodegradable mats, tarps, or materials (already in EM385-1-1)	09/20/11 [ ] Applicable [ ] Evaluated [ ] Practical
Implemented? ("N/A" if "Practical" not checked) [ ] Fully [ ] Partially [ ] Not Yet [x] N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): [ ] Cost Increase [ ] Cost Savings [ ] Cost Neutral [ ] N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): [ ] Environmental [ ] Economic [ ] Social	Level of Up-Front Investment Included in 5 Year Cost Impact: [ ] Negligible [ ] <$10,000 [ ] $10,001-$50,000 [ ] $50,001-$100,000 [ ] $100,001-$500,000 [ ] >$500,000
Resources Conserved: [ ] Hazardous Air Pollutants [ ] Energy [ ] Waste [ ] Criteria Pollutants [ ] Materials [ ] Safety/Community [ ] GHG Emissions [ ] Water [ ] Land Use	[ ] BMP Otherwise Required If so, required by:
Notes: No activities generate dust.	

BMP I-3: Select transportation routes for trucks and heavy equipment that minimize impacts to residential areas to maximize safety and minimize noise and other aesthetic impacts	09/20/11 ☑ Applicable ☐ Evaluated ☑ Practical
Implemented? ("N/A" if "Practical" not checked) ☑ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☑ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☑ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ <$10,000 ☐ $10,001-$50,000 ☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000
Resources Conserved: ☐ Hazardous Air Pollutants ☐ Energy ☐ Waste ☐ Criteria Pollutants ☐ Materials ☑ Safety/Community ☐ GHG Emissions ☐ Water ☐ Land Use	☐ BMP Otherwise Required If so, required by:
Notes: This BMP was not explicitly discussed during the Step 5 call, but it is assumed that the field crews would use the most efficient routes when mobilizing and demobilizing.	

BMP I-4: Minimize drawdown of the water table in areas that could impact production rates at supply wells and/or irrigation wells	09/20/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☑ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ <$10,000 ☐ $10,001-$50,000 ☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000
Resources Conserved: ☐ Hazardous Air Pollutants ☐ Energy ☐ Waste ☐ Criteria Pollutants ☐ Materials ☐ Safety/Community ☐ GHG Emissions ☐ Water ☐ Land Use	☐ BMP Otherwise Required If so, required by:
Notes: Not applicable at the SI level.	

BMP I-5: Minimize amount of time that heavy machinery is needed to enhance safety	09/20/11 ☑ Applicable ☐ Evaluated ☑ Practical

Implemented? ("N/A" if "Practical" not checked) ☑ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☑ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☑ Environmental ☑ Economic ☑ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ <$10,000 ☐ $10,001-$50,000 ☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000
Resources Conserved: ☑ Hazardous Air Pollutants ☑ Energy ☐ Waste ☑ Criteria Pollutants ☐ Materials ☑ Safety/Community ☑ GHG Emissions ☐ Water ☐ Land Use	☐ BMP Otherwise Required If so, required by:

Notes:

Similar to BMP I-3, this point was not explicitly discussed or considered, but it can be assumed that the drilling rigs are only in use when wells are being installed, and no other heavy equipment is used.

BMP I-6: Minimize handling of dangerous chemicals by selecting alternate chemicals and/or engineering to minimize contact with chemicals (for MMRP projects, there is enhanced risk related to explosion potential and exposure to chemical agents [CA] and agent breakdown products [ABP] associated with RCWM responses)	09/20/11 ☐ Applicable ☐ Evaluated ☐ Practical

Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☑ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ <$10,000 ☐ $10,001-$50,000 ☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000
Resources Conserved: ☐ Hazardous Air Pollutants ☐ Energy ☐ Waste ☐ Criteria Pollutants ☐ Materials ☐ Safety/Community ☐ GHG Emissions ☐ Water ☐ Land Use	☐ BMP Otherwise Required If so, required by:

Notes:

As stated in BMP G-5, there are no hazardous wastes or other dangerous chemicals used.

BMP I-7: Contribute to local economy when possible Examples: • Consider leasing local office space • Purchase or lease equipment from local vendors • Hire workers from local community	09/20/11 ☑ Applicable ☑ Evaluated ☑ Practical

Implemented? ("N/A" if "Practical" not checked) ☑ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☑ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ <$10,000 ☐ $10,001-$50,000 ☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000

Resources Conserved: ☐ Hazardous Air Pollutants ☐ Energy ☐ Waste ☐ Criteria Pollutants ☐ Materials ☐ Safety/Community ☐ GHG Emissions ☐ Water ☐ Land Use	☐ BMP Otherwise Required If so, required by:

Notes:

The field crews stay in local hotels, eat at local restaurants, and purchase any supplies at local stores.

BMP J-1: Limit hazard classification to the lowest level that is adequate Examples: • Non-hazardous instead of hazardous landfill if no hazardous materials present • Cap of soil cover does not require OSHA's HAZWOPER standard for cleanup operations if only clean fill • Lowest level of protective clothing that is necessary • Elimination of need for CON/HTRW project if clear historical evidence tank removed and no contamination or no tank	09/20/11 ☑ Applicable ☑ Evaluated ☑ Practical
Implemented? ("N/A" if "Practical" not checked) ☑ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☑ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☑ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ <$10,000 ☐ $10,001-$50,000 ☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000
Resources Conserved: ☐ Hazardous Air Pollutants ☐ Energy ☐ Waste ☐ Criteria Pollutants ☑ Materials ☑ Safety/Community ☐ GHG Emissions ☐ Water ☐ Land Use	☐ BMP Otherwise Required If so, required by:
Notes: Field crews wear level D protective clothing which is the lowest level required. No other hazard classification is required at this point.	

BMP J-2: Have an independent party or group perform a Quality Control review of any draft work plans or other documents (performance reviews, optimization studies, etc.)	09/20/11 ☑ Applicable ☑ Evaluated ☑ Practical
Implemented? ("N/A" if "Practical" not checked) ☑ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☑ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ <$10,000 ☐ $10,001-$50,000 ☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000
Resources Conserved: ☐ Hazardous Air Pollutants ☐ Energy ☐ Waste ☐ Criteria Pollutants ☐ Materials ☐ Safety/Community ☐ GHG Emissions ☐ Water ☐ Land Use	☐ BMP Otherwise Required If so, required by:
Notes: The SI work plan was independently reviewed.	

BMP J-3:	09/20/11
	☐ Applicable ☐ Evaluated ☐ Practical

Implemented? ("N/A" if "Practical" not checked)	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
☐ Fully ☐ Partially ☐ Not Yet ☐ N/A	☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ <$10,000 ☐ $10,001-$50,000 ☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000
Resources Conserved: ☐ Hazardous Air Pollutants ☐ Energy ☐ Waste ☐ Criteria Pollutants ☐ Materials ☐ Safety/Community ☐ GHG Emissions ☐ Water ☐ Land Use	☐ BMP Otherwise Required If so, required by:
Notes:	

BMP J-4:	09/20/11
	☐ Applicable ☐ Evaluated ☐ Practical

Implemented? ("N/A" if "Practical" not checked)	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary):
☐ Fully ☐ Partially ☐ Not Yet ☐ N/A	☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ <$10,000 ☐ $10,001-$50,000 ☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000
Resources Conserved: ☐ Hazardous Air Pollutants ☐ Energy ☐ Waste ☐ Criteria Pollutants ☐ Materials ☐ Safety/Community ☐ GHG Emissions ☐ Water ☐ Land Use	☐ BMP Otherwise Required If so, required by:
Notes:	

BMP J-5:	09/20/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ <$10,000 ☐ $10,001-$50,000 ☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000
Resources Conserved: ☐ Hazardous Air Pollutants ☐ Energy ☐ Waste ☐ Criteria Pollutants ☐ Materials ☐ Safety/Community ☐ GHG Emissions ☐ Water ☐ Land Use	☐ BMP Otherwise Required If so, required by:
Notes:	

BMP J-6:	09/20/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? ("N/A" if "Practical" not checked) ☐ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ <$10,000 ☐ $10,001-$50,000 ☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000
Resources Conserved: ☐ Hazardous Air Pollutants ☐ Energy ☐ Waste ☐ Criteria Pollutants ☐ Materials ☐ Safety/Community ☐ GHG Emissions ☐ Water ☐ Land Use	☐ BMP Otherwise Required If so, required by:
Notes:	

BMP J-7:	09/20/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? (“N/A” if “Practical” not checked) ☐ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ <$10,000 ☐ $10,001-$50,000 ☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000
Resources Conserved: ☐ Hazardous Air Pollutants ☐ Energy ☐ Waste ☐ Criteria Pollutants ☐ Materials ☐ Safety/Community ☐ GHG Emissions ☐ Water ☐ Land Use	☐ BMP Otherwise Required If so, required by:
Notes:	

BMP J-8:	09/20/11 ☐ Applicable ☐ Evaluated ☐ Practical
Implemented? (“N/A” if “Practical” not checked) ☐ Fully ☐ Partially ☐ Not Yet ☐ N/A	Qualitative Net Cost Impact Over 5 Years, No Discounting (discuss in notes if necessary): ☐ Cost Increase ☐ Cost Savings ☐ Cost Neutral ☐ N/A
GSR Parameter Categories Addressed by the BMP for this Project (check all that apply): ☐ Environmental ☐ Economic ☐ Social	Level of Up-Front Investment Included in 5 Year Cost Impact: ☐ Negligible ☐ <$10,000 ☐ $10,001-$50,000 ☐ $50,001-$100,000 ☐ $100,001-$500,000 ☐ >$500,000
Resources Conserved: ☐ Hazardous Air Pollutants ☐ Energy ☐ Waste ☐ Criteria Pollutants ☐ Materials ☐ Safety/Community ☐ GHG Emissions ☐ Water ☐ Land Use	☐ BMP Otherwise Required If so, required by:
Notes:	

APPENDICES B, C1, and C2

Assumptions and Calculations for SiteWise Input

Appendix B
Assumptions and Calculations for Footprinting of Schilling S-1 Site Investigation Using SiteWise

Baseline Footprint

Alternative Created in SiteWise Under Directory Named: "RA_S-1 Baseline_NoFR_1"

Site Inspections represent a discrete event and footprint calculations are for a one time activity, they are not based on repeated annual activities. The inspection includes the following activities:

- Mobilization and demobilization of personnel and equipment
- Installation of the five monitoring wells and collection of soil samples from two additional spots
- Collection of one round of groundwater samples using low-flow methods
- Shipment of soil and groundwater samples to the laboratory
- Any treatment and handling of IDW generated while drilling and sampling

To calculate the footprint contribution of transporting materials to the Site, SiteWise uses a method in which the fuel efficiency of an on-road truck used to transport the materials decreases as more weight is added to it. This method is only used to calculate the footprint of transporting materials that are unique for a particular alternative. For example, the baseline activities assume that portable GAC units are brought to the Site. Since this activity is not performed for all alternatives, the footprint of transporting the portable GAC units is calculated by using the method mentioned above.

Labor times are only calculated for the time that workers spend on-site. Time spent driving is not included in the hours worked since separate calculations are performed for the risk associated with driving and the risk associated with working on-site.

For material calculations, assume unit weights are 120 lb/ft^3 for sand, 100 lb/ft^3 for bentonite, 150 lb/ft^3 for cement.

Scope of Work

- Mobilization of personnel and equipment to the Site
    - Assume two heavy vehicles travel to the Site from Kansas City (170 miles one way, one passenger each). The two vehicles are the mud rotary drill rig and a tool/water truck.
    - Personnel demobilize after working four days at the Site. All personnel travel back to Kansas City in a light truck which also mobilizes to the Site. The drill rig and support truck stay on-site until all drilling is complete.
    - While performing drilling and installation, vehicle trips would be made between the hotel where workers are staying and the Site. Assume that for each day spent at the Site, two trips are made to and from the hotel (10 miles one-way).
- Installation of the five monitoring wells and collection of two additional soil samples

- The drilling method used is mud rotary. Assume that using mud rotary, a well can be completed in 14.5 hours (this assumes a completion rate of 55 feet/day, 10 hour days, and 80 foot wells). Assume that diesel fuel is used.
- Working ten hour days, it takes a total of 72.5 hours to install five wells. This translates to eight days spent drilling. The drilling crew consists of four people, and total hours on-site installing wells is 290
- For collection of soil samples at two additional locations, assume a production rate of 1 boring per day. This translates to 20 hours spent drilling over two days.
- Materials to complete the well include PVC, sand, bentonite, cement, and steel. A six inch boring is created, and a 2" PVC pipe is installed. For grouting and filling of the borehole, a 4" annular space (area of 0.175 ft^2) must be filled. For a ten inch screen, sand fills the bottom 15 feet of the boring, and bentonite grout fills the remaining 65 feet. A four foot steel casing, with 6 inch diameter is installed at the top of the boring, and 2.8 ft^3 of concrete are used to create a flush mount for the well. Both the PVC pipe and steel casing are Schedule 40 thickness.
- Both of the soil sample borings are filled with bentonite grout. Total volume for each boring is depth (80 feet) multiplied by the area of the boring (0.20 ft^2).
- Solid IDW is generated at each boring. The volume of IDW per boring is based on the volume of an 80 foot x 6 inch borehole, and is equal to 15.7 ft^3. Assuming that the solid IDW weighs 110 lb/ft^3 and including a 15% expansion factor (which also accounts for the small amount of bentonite added to drilling fluids), the weight if IDW per borehole is 1990 lbs.
- Liquid IDW is also generated at each boring due to well drilling and well development. A report by Masten and Davis, which is referenced at the end of this appendix, indicated that 2000 gallons of water would be used for drilling fluid make up water at each well. A conservative estimate of the amount of drilling fluid lost to the formation would be fifty percent (a report on the National Groundwater Association webpage cited cases where as much as 80-90% of drilling fluid was lost to the formation: http://info.ngwa.org/gwol/pdf/961161852.PDF). This would leave 1000 gallons of liquid IDW after drilling alone. Well development would produce an additional amount of liquid IDW. The Army Corps of Engineers monitoring well engineering manual, EM 1110-1-4000, states that 3 times the amount of drilling fluid lost to the formation plus three times the standing water volume in the casing must be removed. Standing water volume in the casing is equal to the water in the casing (assumed to be the screened length of 10 feet) plus the water in the filter pack around the casing (assumes porosity of 30% and annular space of 2"). The total water volume that would be purged is then equal to 3000 gallons plus 6 gallons. Assuming that a pump similar to the one found here http://www.groundwaterinnovations.com/buffalo-air-pump.php would be used for well development, the total time spent pumping would be equal to the amount of water extracted for development (3006 gallons) divided by the pump flowrate (6 gpm). Time spent pumping would be equal to 8.4 hours. Assume that this pumping is completed while other operations are happening, so no additional days are spent on-site solely for well development. Also assume that the pump would be powered by a portable generator consuming 0.4 gallons (similar to the generator used for low-flow sampling in the next bulleted list).

- Collection of groundwater samples using low-flow sampling methods
  - A sampling crew consisting of two persons would make a dedicated trip from Kansas City to the site (170 miles one way). The trip could be made in a light truck. An additional trip to and from a hotel (10 miles one way) would be required.
  - Sampling would be done with bladder pumps. Assume that a low-flow sample is collected by purging water for 30 minutes at a rate of 300 mL/min.
  - A portable motor would most likely be used to power the bladder pump. Assume that a 4 HP Honda engine, www.pine-environmental.com/bladder-pump-system.htm, would be used. With a manufacturer specified gasoline consumption rate of 0.4 gal/hr, pumping for 30 minutes would consume 0.2 gallons of gasoline for each well sampled.
  - All wells could be sampled in one day, giving a total amount of labor of 20 hours (10 hours per worker).
- Shipment of soil and groundwater samples to the laboratory
  - To satisfy sample holding time requirements, samples would probably be shipped every two days for soil sampling. For ten days of drilling, that would translate to five trips to the nearest shipping drop off location (30 miles away in Salina, KS).
  - The analysis lab is located nearly nine hundred miles away so assume samples are flown to the lab. Each sample cooler weighs approximately 50 pounds when filled. This assumption of weight is used in the SiteWise module for air transportation.
- Treatment of liquid IDW and disposal of solid IDW
  - Liquid IDW is stored in two - 2000 gallon poly tank (empty weight 430 lbs each) and run through a portable GAC unit using regenerated GAC then dumped on-site. A typical portable GAC unit (http://acquabella.net/L-200%20specs.htm) would use 190 lbs of GAC. At flow rates of 10 gpm, a portable pump similar to the one found at http://robinamerica.com/pspecs.aspx?pid=157 would use gasoline at 0.10 gal/hr. To treat the water in a reasonable timeframe, assume that three portable units are operated, each with the same characteristics. Treating the 4006 gallons of liquid IDW from each boring would use 6.7 gallons of gasoline per boring.
  - For transportation of the GAC units and barrels for containerizing solid IDW, assume that the unit and pump are transported by a dedicated heavy truck trip from Kansas City, and the GAC treatment unit weighs 270 pounds total. Since the heavy truck is making a dedicated trip to drop off and pick up the GAC units and 55 gallon drums used for solid IDW, an empty trip needs to be included.
  - Solid IDW is containerized in 55 gallon drums (empty weight of 40 lbs). Once test results confirm acceptable contamination levels, the drums are emptied onto the ground on-site. There is no footprint associated with this.

Appendix B – Calculation of Baseline Footprint

Input into "Remedial Investigation" tab of SiteWise Input Sheet.xls

- Baseline Information
    - Remedial Action Operations Cost and Duration
        - Total remedial investigation cost ($) – leave blank
        - In the "Site Information" tab the electricity region is set to SPNO. This is simply for bookkeeping since there is no on-site electricity usage.

- Material Production
    - Well Materials
        - PVC casing: 5 wells, 80 feet deep, Sch 40 PVC, 2 inch diameter
        - Steel protective casing: 5 wells, 4 feet deep, Sch 40 steel, 6 inch diameter
    - Treatment Chemicals & Materials
    - Treatment Media
        - GAC for IDW treatment: 570 lbs, Regenerated GAC
    - Construction Materials
    - Well Decommissioning
    - Bulk Material Quantities
        - Bentonite: 8888 lbs, Cement: 2100 lbs, Sand: 1575 lbs

- Transportation
    - Personnel Transportation – Road
        - Drill Rig/Tool Truck: Trip 1 & Trip 2, Heavy Duty, Diesel, 1 trip, 340 miles, 1 traveler
        - Light Truck Deployment: Trip 3, Light Truck, Gasoline, 4 trips, 340 miles, 2 travelers
        - Light Truck Daily Travel: Trip 4, Light Truck, Gasoline, 24 trips, 20 miles, 2 travelers
        - Light Truck Sample Delivery: Trip 5, Light Truck, Gasoline, 6 trips, 60 miles, 2 travelers
    - Personnel Transportation – Air
    - Personnel Transportation – Rail
    - Equipment Transportation – Road
        - Transportation of GAC units , poly tanks, and empty IDW barrels: Trip 1, Diesel, 340 miles, 1.135 tons
        - Empty return trips of transportation truck: Trip 2, Diesel, 340 miles, 0.00 tons.
    - Equipment Transportation – Air
        - Sample shipment: Trip 1, 900 miles, 0.15 tons
    - Equipment Transportation – Rail
    - Equipment Transportation – Water

- Equipment Use
    - Earthwork
    - Drilling
        - Well installation: Equipment 1,5 locations, Mud Rotary, 14.5 hours, diesel
        - Additional sample collection: Equipment 2, 2 locations, Mud Rotary, 10 hours, diesel
    - Trenching

- Pump Operation
- Diesel and Gasoline Pumps
- Blower, Compressor, Mixer, and Other Equipment
- Generators
- Agricultural Equipment
- Capping Equipment
- Mixing Equipment
- Internal Combustion Engines
  - Bladder pump and portable GAC pumps: Engine 1, Gasoline, instead of putting gallons of fuel per hour, enter the gallons of fuel per well (0.2 gallons for low-flow sampling, 3.4 gallons for development, and 6.7 gallons for GAC treatment), and in the cell requesting operating hours, enter the number of wells sampled (5 wells). This will calculate the total fuel consumption.
- Other Fueled Equipment
- Operator Labor
  - Occupation 1: Scientific and Technical Services, 390 hours (includes all labor)
- Laboratory Analysis
- Other Known Onsite Activities

- Residual Handling
  - Residue Disposal/Recycling
  - Landfill Operations
  - Thermal/Catalytic Oxidizers

- Resource Consumption
  - Water Consumption
    - Water for drilling mud: Treatment System 1, 14000 gallons
  - Onsite Land and Water Resource Consumption

Once SiteWise input is complete, go to “SiteWise_Input Sheet ” for overall project and enter information (including Alternative File Name “ S-1 Baseline”). Then go to “Generate Alternative” tab and click button labeled “Click to generate alternative using previously entered alternative name”. Copies of the input and output summary sheets for this alternative are now located in the directory titled “RA_ S-1 Baseline _NoFR_1”. To store the “Remedial Action Opeartions.xls” calculation sheet showing detailed calculations, open it in the overall SiteWise project directory when the appropriate input sheet is open, then do a “save as” to put it in the directory for this alternative using a name that indicates “will not update”. Then open that file and do “data->edit links” and break the links. If the input sheet for this alternative ever changes, then this calculation sheet needs to be re-saved.

To edit input parameters for this alternative, you must go back to the ORIGINAL SiteWise input sheet and import this alternative using the “Do you want to reload a previously saved remedial alternative in the SiteWise input sheet?” field on the “Site Info” tab. After making necessary changes to the input sheet, re-export the alternative by going to the “Generate Alternative” tab and clicking the button labeled “Click to replace an existing alternative with the same name”. Update saved calculation sheets as described above.

Other Supporting Calculations:
Current P&T Systems (Baseline)

% of Total Energy Usage from Renewable Resources

- Not considered. For this Site, no electrical use was determined from the footprint models. All electrical equipment is powered by fossil fuel generators.

Hazardous Air Pollutants

- None identified

.

Refined Materials Use

- Refined materials include the PVC, steel, and cement used in well completion as well as the regenerated GAC used to treat the drilling fluid. The total weights of these materials are found in the SiteWise calculation sheets.

Unrefined Materials Use

- Unrefined materials include the sand and bentonite used in well completion. The total weights of these materials are found in the SiteWise calculation sheets.

Tons of Non-Hazardous Waste

- Not quantified. A certain amount of waste associated with Personal Protective Equipment (PPE) would be generated, but this is difficult to define.

Tons of Hazardous Waste

- None identified. Any regenerated GAC used on-site would be recycled again for future use.

Risks to On-Site Workers and from Transportation

- These values are calculated in SiteWise. Since SiteWise combines risk from miles driven and on-site work, the individual values have to be located in the SiteWise calculation sheets.

Heavy Truck Trips through Residential Areas

- None identified

Appendix C1
Assumptions and Calculations for Footprinting of Schilling S-1 Site Investigation Using SiteWise

Alternative 1 – Off-Site Disposal of IDW

SiteWise "RA_ S-1 Alternative1_NoFR_1" Directory

Site Inspections represent a discrete event and footprint calculations are for a one time activity, they are not based on repeated annual activities. The inspection includes the following activities:

- Mobilization and demobilization of personnel and equipment
- Installation of the five monitoring wells and collection of soil samples from two additional spots
- Collection of one round of groundwater samples using low-flow methods
- Shipment of soil and groundwater samples to the laboratory
- Any treatment and handling of IDW generated while drilling and sampling

One activity that is not modeled in the baseline calculation is well development. The reason for excluding this is that well development can be accomplished using a variety of methods. Since part of the goal of developing footprint calculations is to compare different alternatives, it is not important to include well development methods since they would be the same for each alternative (which means the footprints would be the same).

To calculate the footprint contribution of transporting materials to the Site, SiteWise uses a method in which the fuel efficiency of an on-road truck decreases as more weight is added to it. This method is only used to calculate the footprint of transporting materials that are unique for a particular alternative. For example, the baseline activities assume that portable GAC units are brought to the Site. Since this is specific for only the baseline activities, the footprint of transporting the portable GAC units is calculated by using the method mentioned above.

Labor times are only calculated for the time that workers spend on-site. Time spent driving is not included in the hours worked since separate calculations are performed for the risk associated with driving and the risk associated with working on-site.

For material calculations, assume unit weights are 120 lb/ft^3 for sand, 100 lb/ft^3 for bentonite, 150 lb/ft^3 for cement.

Scope of Work

- Mobilization of personnel and equipment to the Site
    - Assume two heavy vehicles travel to the Site from Kansas City (170 miles one way, one passenger each). The two vehicles are the mud rotary drill rig and a tool/water truck.
    - Personnel demobilize after working four days at the Site. All personnel travel back to Kansas City in a light truck. The drill rig and support truck stay on-site until all drilling is complete.

- While performing drilling and installation, vehicle trips would be made between the hotel where workers are staying and the Site. Assume that for each day spent at the Site, two trips are made to and from the hotel (10 miles one-way).

- Installation of the five monitoring wells and collection of two additional soil samples
  - The drilling method used is mud rotary. Assume that using mud rotary, a well can be completed in 14.5 hours (this assumes a completion rate of 55 feet/day, 10 hour days, and 80 foot wells). Assume that diesel fuel is used.
  - Working ten hour days, it takes a total of 72.5 hours to install five wells. This translates to eight days spent drilling. The drilling crew consists of four people, and total hours on-site installing wells is 290
  - For collection of soil samples at two additional locations, assume a production rate of 1 boring per day. This translates to 20 hours spent drilling over two days.
  - Materials to complete the well include PVC, sand, bentonite, cement, and steel. A six inch boring is created, and a 2" PVC pipe is installed. For grouting and filling of the borehole, a 4" annular space (area of 0.175 ft^2) must be filled. For a ten inch screen, sand fills the bottom 15 feet of the boring, and bentonite grout fills the remaining 65 feet. A four foot steel casing, with 6 inch diameter is installed at the top of the boring, and 2.8 ft^3 of concrete are used to create a flush mount for the well. Both the PVC pipe and steel casing are Schedule 40 thickness.
  - Both of the soil sample borings are filled with bentonite grout. Total volume for each boring is depth (80 feet) multiplied by the area of the boring (0.20 ft^2).
  - Solid IDW is generated at each boring. The volume of IDW per boring is based on the volume of an 80 foot x 6 inch borehole, and is equal to 15.7 ft^3. Assuming that the solid IDW weighs 110 lb/ft^3 and including a 15% expansion factor (which also accounts for the small amount of bentonite added to drilling fluids), the weight if IDW per borehole is 1990 lbs.
  - Liquid IDW is also generated at each boring due to well drilling and well development. A report by Masten and Davis, which is referenced at the end of this appendix, indicated that 2000 gallons of water would be used for drilling fluid make up water at each well. A conservative estimate of the amount of drilling fluid lost to the formation would be fifty percent (a report on the National Groundwater Association webpage cited cases where as much as 80-90% of drilling fluid was lost to the formation: http://info.ngwa.org/gwol/pdf/961161852.PDF). This would leave 1000 gallons of liquid IDW after drilling alone. Well development would produce an additional amount of liquid IDW. The Army Corps of Engineers monitoring well engineering manual, EM 1110-1-4000, states that 3 times the amount of drilling fluid lost to the formation plus three times the standing water volume in the casing must be removed. Standing water volume in the casing is equal to the water in the casing (assumed to be the screened length of 10 feet) plus the water in the filter pack around the casing (assumes porosity of 30% and annular space of 2"). The total water volume that would be purged is then equal to 3000 gallons plus 6 gallons. Assuming that a pump similar to the one found here http://www.groundwaterinnovations.com/buffalo-air-pump.php would be used for well development, the total time spent pumping would be equal to the amount of water extracted for development (3006 gallons) divided by the pump flowrate (6 gpm). Time

spent pumping would be equal to 8.4 hours. Assume that this pumping is completed while other operations are happening, so no additional days are spent on-site solely for well development. Also assume that the pump would be powered by a portable generator consuming 0.4 gallons (similar to the generator used for low-flow sampling in the next bulleted list).

- Collection of groundwater samples using low-flow sampling methods
    - A sampling crew consisting of a two persons would make a dedicated trip from Kansas City to the site (170 miles one way). The trip could be made in a light truck. An additional trip to and from a hotel (10 miles one way) would be required.
    - Sampling would be done with bladder pumps. Assume that a low-flow sample is collected by purging water for 30 minutes at a rate of 300 mL/min.
    - A portable motor would most likely be used to power the bladder pump. Assume that a 4 HP Honda engine, www.pine-environmental.com/bladder-pump-system.htm, would be used. With a manufacturer specified gasoline consumption rate of 0.4 gal/hr, pumping for 30 minutes would consume 0.2 gallons of gasoline for each well sampled.
    - All wells could be sampled in one day, giving a total amount of labor of 20 hours (10 hours per worker).
- Shipment of soil and groundwater samples to the laboratory
    - To satisfy sample holding time requirements, samples would probably be shipped every two days for soil sampling. For ten days of drilling, that would translate to five trips to the nearest shipping drop off location (30 miles away in Salina, KS).
    - The analysis lab is located nearly nine hundred miles away so assume samples are flown to the lab. Each sample cooler weighs approximately 50 pounds when filled. This assumption of weight is needed in SiteWise.
- Treatment and Handling of IDW
    - For off-site treatment of liquid IDW, assume that a septic tank truck makes a dedicated trip from Salina, KS (the nearest landfill) to pick up the drilling fluid and then return it to the landfill for disposal. The total volume of liquid IDW generated was found to be 4006 gallons. Assuming that only two 2000 gallon poly tanks would be brought to the Site, a septic tank truck would have to make a separate trip to pick up liquid IDW generated at each borehole. The transported weight for each trip would be equal to the weight of 4006 gallons of water, 16.7 tons.
    - Solid IDW is containerized in 55 gallon drums (empty weight of 40 lbs).For seven boreholes, the total volume and weight of IDW would be 127 ft^3 and 13,930 lbs. The number of 55 gallon drums needed to containerize IDW would be roughly 18 drums. Assume that a heavy duty vehicle comes from Salina, KS, and delivers the drummed IDW, total weight of 14700 lbs including the weight of the drums, to the landfill in Salina.
    - Assume that a heavy duty truck drives from Kansas City to the Site to deliver the 2000 gallon poly tanks and 55 gallon drums needed for IDW containment. Total weight of the empty 2000 gallon poly tanks is 430 lbs each , and the eighteen 55 gallon drums weigh

720 lbs. Since the 55 gallon drums are taken to a landfill, only the 2000 gallon poly tanks needs to be returned to Kansas City.

Input into "Remedial Investigation" tab of SiteWise Input Sheet.xls

- Baseline Information
  - Remedial Action Operations Cost and Duration
    - Total remedial investigation cost ($) – leave blank
    - In the "Site Information" tab the electricity region is set to SPNO. This is simply for bookkeeping since there is no on-site electricity usage.

- Material Production
  - Well Materials
    - PVC casing: 5 wells, 80 feet deep, Sch 40 PVC, 2 inch diameter
    - Steel protective casing: 5 wells, 4 feet deep, Sch 40 steel, 6 inch diameter
  - Treatment Chemicals & Materials
  - Treatment Media
    - GAC for IDW treatment: 570 lbs, Regenerated GAC
  - Construction Materials
  - Well Decommissioning
  - Bulk Material Quantities
    - Bentonite: 8888 lbs, Cement: 2100 lbs, Sand: 1575 lbs

- Transportation
  - Personnel Transportation – Road
    - Drill Rig/Tool Truck: Trip 1 & Trip 2, Heavy Duty, Diesel, 1 trip, 340 miles, 1 traveler
    - Light Truck Deployment: Trip 3, Light Truck, Gasoline, 4 trips, 340 miles, 2 travelers
    - Light Truck Daily Travel: Trip 4, Light Truck, Gasoline, 24 trips, 20 miles, 2 travelers
    - Light Truck Sample Delivery: Trip 5, Light Truck, Gasoline, 6 trips, 60 miles, 2 travelers
  - Personnel Transportation – Air
  - Personnel Transportation – Rail
  - Equipment Transportation – Road
    - Transportation of poly tank and 55 gallon drums to site: Trip 1, Diesel, 170 miles, 0.58 tons
    - Empty trips of transportation truck: Trip 2, Diesel, 340 miles, 0.00 tons
    - Transportation of poly tank from the Site: Trip 3, Diesel, 170 miles, 0.43 tons
    - Septic tank truck driving to Site to pick up liquid IDW: Trip 4, Diesel, 30 miles x 7 trips = 210 miles, 0.00 tons
    - Septic tank truck driving from site with liquid IDW: Trip 5, Diesel, 30 miles x 7 trips = 210 miles, 16.7 tons
    - Truck driving to site to pick up soil cuttings: Trip 6, Diesel, 30 miles, 0.00 tons
    - Truck driving from Site with soil cuttings: Trip 7, Diesel, 30 miles, 7.35 tons

        - Note that since SiteWise only allows for six trips to be entered, the mileage for empty trips are all combined into one trip.
    - Equipment Transportation – Air
        - Sample shipment: Trip 1, 900 miles, 0.15 tons (
    - Equipment Transportation – Rail
    - Equipment Transportation – Water

- Equipment Use
    - Earthwork
    - Drilling
        - Well installation: Equipment 1,5 locations, Mud Rotary, 14.5 hours, diesel
        - Additional sample collection: Equipment 2, 2 locations, Mud Rotary, 10 hours, diesel
    - Trenching
    - Pump Operation
    - Diesel and Gasoline Pumps
    - Blower, Compressor, Mixer, and Other Equipment
    - Generators
    - Agricultural Equipment
    - Capping Equipment
    - Mixing Equipment
    - Internal Combustion Engines
        - Bladder pump : Engine 1, Gasoline, fuel consumption rate is entered as fuel consumption rate per well, not per hour, and is equal to 0.2 gallons for sampling plus 3.4 gallons for development. Hours operating is used to enter the number of wells, which is five.
    - Other Fueled Equipment
    - Operator Labor
        - Occupation 1: Scientific and Technical Services, 390 hours (includes all labor)
    - Laboratory Analysis
    - Other Known Onsite Activities

- Residual Handling
    - Residue Disposal/Recycling
    - Landfill Operations
        - Operation 1, Non-hazardous, 6.97 tons of waste disposed to landfill, no input for landfill methane emissions.
    - Thermal/Catalytic Oxidizers

- Resource Consumption
    - Water Consumption
        - Water for drilling mud: Treatment System 1, 14000 gallons
    - Onsite Land and Water Resource Consumption

Once SiteWise input is complete, go to "SiteWise_Input Sheet " for overall project and enter information (including Alternative File Name " S-1 Alternative 1"). Then go to "Generate Alternative" tab and click button labeled "Click to generate alternative using previously entered alternative name".

Copies of the input and output summary sheets for this alternative are now located in the directory titled "RA_ S-1 Alternative 1 _NoFR_1". To store the "Remedial Action Opeartions.xls" calculation sheet showing detailed calculations, open it in the overall SiteWise project directory when the appropriate input sheet is open, then do a "save as" to put it in the directory for this alternative using a name that indicates "will not update". Then open that file and do "data->edit links" and break the links. If the input sheet for this alternative ever changes, then this calculation sheet needs to be re-saved.

To edit input parameters for this alternative, you must go back to the ORIGINAL SiteWise input sheet and import this alternative using the "Do you want to reload a previously saved remedial alternative in the SiteWise input sheet?" field on the "Site Info" tab. After making necessary changes to the input sheet, re-export the alternative by going to the "Generate Alternative" tab and clicking the button labeled "Click to replace an existing alternative with the same name". Update saved calculation sheets as described above.

Other Supporting Calculations
Alternative 1 – Transport All IDW to Off-site Landfill

% of Total Energy Usage from Renewable Resources

- Not considered. For this Site, no electrical use was determined from the footprint models. All electrical equipment is powered by fossil fuel generators.

Hazardous Air Pollutants

- None identified

.

Refined Materials Use

- Refined materials include the PVC, steel, and cement used in well completion as well as the regenerated GAC used to treat the drilling fluid. The total weights of these materials are found in the SiteWise calculation sheets.

Unrefined Materials Use

- Unrefined materials include the sand and bentonite used in well completion. The total weights of these materials are found in the SiteWise calculation sheets.

Tons of Non-Hazardous Waste

- Equal to the amount of drill cuttings sent off-site for disposal.

Tons of Hazardous Waste

- None.

Risks to On-Site Workers and from Transportation

- These values are calculated in SiteWise. Since SiteWise combines risk from miles driven and on-site work, the individual values have to be located in the SiteWise calculation sheets.

Heavy Truck Trips through Residential Areas

- None identified

Appendix C2 πM
Assumptions and Calculations for Footprinting of Schilling S-1 Site Investigation Using SiteWise

Alternative 2 – Use of an Alternate Drilling Method

SiteWise "RA_ S-1 Alternative2_NoFR_1" Directory

Site Inspections represent a discrete event and footprint calculations are for a one time activity, they are not based on repeated annual activities. The inspection includes the following activities:

- Mobilization and demobilization of personnel and equipment
- Installation of the five monitoring wells and collection of soil samples from two additional spots
- Collection of one round of groundwater samples using low-flow methods
- Shipment of soil and groundwater samples to the laboratory
- Any treatment and handling of IDW generated while drilling and sampling

One activity that is not modeled in the baseline calculation is well development. The reason for excluding this is that well development can be accomplished using a variety of methods. Since part of the goal of developing footprint calculations is to compare different alternatives, it is not important to include well development methods since they would be the same for each alternative (which means the footprints would be the same).

To calculate the footprint contribution of transporting materials to the Site, SiteWise uses a method in which the fuel efficiency of an on-road truck decreases as more weight is added to it. This method is only used to calculate the footprint of transporting materials that are unique for a particular alternative. For example, the baseline activities assume that portable GAC units are brought to the Site. Since this is specific for only the baseline activities, the footprint of transporting the portable GAC units is calculated by using the method mentioned above.

Labor times are only calculated for the time that workers spend on-site. Time spent driving is not included in the hours worked since separate calculations are performed for the risk associated with driving and the risk associated with working on-site.

For material calculations, assume unit weights are 120 lb/ft^3 for sand, 100 lb/ft^3 for bentonite, 150 lb/ft^3 for cement.

<u>*Scope of Work*</u>

- Mobilization of personnel and equipment to the Site
    - o Assume two heavy vehicles travel to the Site from Kansas City (170 miles one way, one passenger each). The two vehicles are the rotary sonic drilling rig and a support truck.
    - o Personnel demobilize after working four days at the Site. All personnel travel back to Kansas City in a light truck. The drill rig and support truck stay on-site until all drilling is complete.

  - An additional support vehicle travels to the Site. Modeled as a light truck, carrying two passengers.
  - While performing drilling and installation, vehicle trips would be made between the hotel where workers are staying and the Site. Assume that for each day spent at the Site, two trips are made to and from the hotel (10 miles one-way).
- Installation of the five monitoring wells and collection of two additional soil samples
  - The drilling method used is rotary sonic. Assume that using rotary sonic, a well can be completed in 15.4 hours (this assumes a completion rate of 52 feet/day, 10 hour days, and 80 foot wells). Assume that diesel fuel is used.
  - Working ten hour days, it takes a total of 77 hours (rounded to eight days for the purpose of calculating vehicle trips) to install five wells. This translates to eight days spent drilling. The drilling crew consists of four people, and total hours on-site installing wells is 308
  - For collection of soil samples at two additional locations, assume a production rate of 1 boring per day. This translates to 20 hours spent drilling over two days.
  - Materials to complete the well include PVC, sand, bentonite, cement, and steel. A six inch boring is created, and a 2" PVC pipe is installed. For grouting and filling of the borehole, a 4" annular space (area of 0.175 ft^2) must be filled. For a ten inch screen, sand fills the bottom 15 feet of the boring, and bentonite grout fills the remaining 65 feet. A four foot steel casing, with 6 inch diameter is installed at the top of the boring, and 2.8 ft^3 of concrete are used to create a flush mount for the well. Both the PVC pipe and steel casing are Schedule 40 thickness.
  - Both of the soil sample borings are filled with bentonite grout. Total volume for each boring is depth (80 feet) multiplied by the area of the boring (0.20 ft^2).
  - Solid IDW is generated at each boring. A study by Masten and Davis reported that one barrel of soil cuttings was generated for every 60 feet drilled. In addition, one barrel of decontamination waste was generated for each borehole.
- Collection of groundwater samples using low-flow sampling methods
  - A sampling crew consisting of a two persons would make a dedicated trip from Kansas City to the site (170 miles one way). The trip could be made in a light truck. An additional trip to and from a hotel (10 miles one way) would be required.
  - Sampling would be done with bladder pumps. Assume that a low-flow sample is collected by purging water for 30 minutes at a rate of 300 mL/min.
  - A portable motor would most likely be used to power the bladder pump. Assume that a 4 HP Honda engine, www.pine-environmental.com/bladder-pump-system.htm, would be used. With a manufacturer specified gasoline consumption rate of 0.4 gal/hr, pumping for 30 minutes would consume 0.2 gallons of gasoline for each well sampled.
  - All wells could be sampled in one day, giving a total amount of labor of 20 hours (10 hours per worker).
- Shipment of soil and groundwater samples to the laboratory

  - To satisfy sample holding time requirements, samples would probably be shipped every two days for soil sampling. For ten days of drilling, that would translate to five trips to the nearest shipping drop off location (30 miles away in Salina, KS).
  - The analysis lab is located nearly nine hundred miles away so assume samples are flown to the lab. Each sample cooler weighs approximately 50 pounds when filled. This assumption of weight is needed in SiteWise.
- Treatment and Handling of IDW
  - Liquid IDW is contained in 55 gallon drums and then run through a portable GAC unit using regenerated GAC and dumped on-site. A typical portable GAC unit (http://acquabella.net/L-200%20specs.htm) would use 190 lbs of GAC. At flow rates of 10 gpm, a portable pump similar to the one found at http://robinamerica.com/pspecs.aspx?pid=157 would use gasoline at 0.10 gal/hr. Since each borehole generates one 55 gallon drum of IDW, a total of 0.1 gallons of fuel would be used to pump the decontamination water from one borehole through the GAC unit.
  - For transportation of the GAC unit and barrels for containerizing solid and liquid IDW, assume that the unit and pump are transported by a dedicated heavy truck trip from Kansas City, and the GAC treatment unit weighs 270 pounds total. Since the heavy truck is making a dedicated trip to drop off and pick up the GAC units and 55 gallon drums used for solid IDW, an empty trip needs to be included.
  - Solid IDW is contained in 55 gallon drums (empty weight of 40 lbs). Once test results confirm acceptable contamination levels, the drums are emptied onto the ground on-site. There is no footprint associated with this.

Input into "Remedial Investigation" tab of SiteWise Input Sheet.xls

- Baseline Information
  - Remedial Action Operations Cost and Duration
    - Total remedial investigation cost ($) – leave blank
    - In the "Site Information" tab the electricity region is set to SPNO. This is simply for bookkeeping since there is no on-site electricity usage.

- Material Production
  - Well Materials
    - PVC casing: 5 wells, 80 feet deep, Sch 40 PVC, 2 inch diameter
    - Steel protective casing: 5 wells, 4 feet deep, Sch 40 steel, 6 inch diameter
  - Treatment Chemicals & Materials
  - Treatment Media
    - GAC for IDW treatment: 190 lbs, Regenerated GAC
  - Construction Materials
  - Well Decommissioning
  - Bulk Material Quantities
    - Bentonite: 8888 lbs, Cement: 2100 lbs, Sand: 1575 lbs

- Transportation
  - Personnel Transportation – Road

        - Drill Rig/Tool Truck: Trip 1 & Trip 2, Heavy Duty, Diesel, 1 trip, 340 miles, 1 traveler
        - Light Truck Deployment: Trip 3, Light Truck, Gasoline, 4 trips, 340 miles, 2 travelers
        - Light Truck Daily Travel: Trip 4, Light Truck, Gasoline, 24 trips, 20 miles, 2 travelers
        - Light Truck Sample Delivery: Trip 5, Light Truck, Gasoline, 6 trips, 60 miles, 2 travelers
    - Personnel Transportation – Air
    - Personnel Transportation – Rail
    - Equipment Transportation – Road
        - Transportation of GAC unit and 55 gallon drums to and from the Site: Trip 1, 340 miles, Diesel, 0.475 tons
        - Empty trips of transportation truck: Trip 2, Diesel, 340 miles, 0.00 tons
    - Equipment Transportation – Air
        - Sample shipment: Trip 1, 900 miles, 0.15 tons
    - Equipment Transportation – Rail
    - Equipment Transportation – Water

- Equipment Use
    - Earthwork
    - Drilling
        - Well installation: Equipment 1,5 locations, Sonic, 15.4 hours, diesel
        - Additional sample collection: Equipment 2, 2 locations, Sonic, 10 hours, diesel
    - Trenching
    - Pump Operation
    - Diesel and Gasoline Pumps
    - Blower, Compressor, Mixer, and Other Equipment
    - Generators
    - Agricultural Equipment
    - Capping Equipment
    - Mixing Equipment
    - Internal Combustion Engines
        - Bladder pump : Engine 1, 1.7 gallon/hour, 1 hour (since total fuel consumption was already calculated, the total amount is entered, not the hourly consumption rate)
    - Other Fueled Equipment
    - Operator Labor
        - Occupation 1: Scientific and Technical Services, 408 hours (includes all labor)
    - Laboratory Analysis
    - Other Known Onsite Activities

- Residual Handling
    - Residue Disposal/Recycling
    - Landfill Operations
    - Thermal/Catalytic Oxidizers

- Resource Consumption

- Water Consumption
- Equipment decontamination: Treatment System 1, 385 gallons
- Onsite Land and Water Resource Consumption

Once SiteWise input is complete, go to "SiteWise_Input Sheet " for overall project and enter information (including Alternative File Name "Alternative2"). Then go to "Generate Alternative" tab and click button labeled "Click to generate alternative using previously entered alternative name". Copies of the input and output summary sheets for this alternative are now located in the directory titled "RA_Alternative2 _NoFR_1". To store the "Remedial Action Opeartions.xls" calculation sheet showing detailed calculations, open it in the overall SiteWise project directory when the appropriate input sheet is open, then do a "save as" to put it in the directory for this alternative using a name that indicates "will not update". Then open that file and do "data->edit links" and break the links. If the input sheet for this alternative ever changes, then this calculation sheet needs to be re-saved.

To edit input parameters for this alternative, you must go back to the ORIGINAL SiteWise input sheet and import this alternative using the "Do you want to reload a previously saved remedial alternative in the SiteWise input sheet?" field on the "Site Info" tab. After making necessary changes to the input sheet, re-export the alternative by going to the "Generate Alternative" tab and clicking the button labeled "Click to replace an existing alternative with the same name". Update saved calculation sheets as described above.

Other Supporting Calculations:
Alternative 2 - Eliminate Individual Water Supply Well Strippers

% of Total Energy Usage from Renewable Resources

- Not considered. For this Site, no electrical use was determined from the footprint models. All electrical equipment is powered by fossil fuel generators.

Hazardous Air Pollutants

- None identified

.

Refined Materials Use

- Refined materials include the PVC, steel, and cement used in well completion as well as the regenerated GAC used to treat the drilling fluid. The total weights of these materials are found in the SiteWise calculation sheets.

Unrefined Materials Use

- Unrefined materials include the sand and bentonite used in well completion. The total weights of these materials are found in the SiteWise calculation sheets.

Tons of Non-Hazardous Waste

- Not quantified. A certain amount of waste associated with Personal Protective Equipment (PPE) would be generated, but this is difficult to define.

Tons of Hazardous Waste

- None identified. Any regenerated GAC used on-site would be recycled again for future use.

Risks to On-Site Workers and from Transportation

- These values are calculated in SiteWise. Since SiteWise combines risk from miles driven and on-site work, the individual values have to be located in the SiteWise calculation sheets.

Heavy Truck Trips through Residential Areas

- None identified

References

ESTCP. (2009). *Demonstration/Validation of Long-Term Monitoring Using Wells Installed by Direct Push Technologies and Enhanced Low-Flow Groundwater Sampling Methods.*

Masten, D., & Booth, S. (1996). The Cost Effectiveness of Sonic Drilling. *Los Alamos National Laboratory* .

Oothoudt, T., & Davis, R. (1997). Drilling Method May be Gold at End of Rainbow for Difficult Terrains. *Soil & Groundwater Cleanup* , 34-36.

Appendix C2-2

Case Study of Alternative 2 – Use of an Alternate Drilling Method

U.S. Army
Green and Sustainable Remediation (GSR)
Case Study

Comparison of the Different Well Installation Techniques

Schilling Air Force Base Atlas Missile Facility S-, Kansas

This case study summarizes a GSR consideration that can be made for nearly any site which requires the installation of wells. Specific GSR practices which could be implemented based on the information in this case study include:

- Planning for sustainability
- Energy/emission reductions
- Water resource conservation
- Reduction of materials use and waste generation
- Improvements related to safety and community

The installation of five monitoring wells at a Formerly Used Defense Site (FUDS) was used as a scenario to model a case study comparing five different methods for monitoring well installation. Drilling methods were included based on frequency of use (cable tool, hollow stem auger, and mud rotary) and potential GSR benefits (direct push and sonic drilling).

Results of the case study showed that mud rotary drilling has the largest environmental impact followed by hollow stem auger, sonic drilling, cable tool, and direct push. Several other insights were also discovered including:

- **Handling of Investigation Derived Waste (IDW) has a relatively small impact compared to the other well installation activities**
- **Not surprisingly, transportation of equipment and personnel was responsible for the majority of the environmental impact of the drilling rigs that utilize the least amount of fuel (cable tool and direct push)**
- **At locations where direct push well installation is feasible, it creates only 36% of the GHG emissions and 4% of the NO_x and SO_x emissions that other common technologies such as hollow stem auger.**

For more information, contact
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Additional Information: https://casi.erdc.usace.army.mil/focusareas/green_remediation/?contentRegion=Item&id=62056

April 2012

Case Study Comparing the Impacts of Different Boring Methods Used for Well Installation

Schilling Air Force Base Atlas Missile Facility S-1; Bennington, Kansas

This case study was done to compare the relative impacts of different well installation techniques. Five installation techniques were chosen for evaluation based on either their frequency of use (cable tool, hollow stem auger and mud rotary) or their potential Green and Sustainable Remediation (GSR) benefit (sonic drilling and direct push). The case study uses the installation of 5 monitoring wells at the Schilling S-1 Atlas Missile Site to demonstrate the comparative impacts of the different drilling methods. Whenever possible, actual data from the project were used to build this scenario, but in some cases assumptions had to be made. Most of those assumptions are fairly simple and are addressed as they come up in the tables on the following pages. However, a few assumptions and decisions are of more importance and are addressed as follows:

- While site geology often determines which drilling technology is applicable, for the purpose of comparing the different drilling technologies it was assumed that the site geology would allow for all 5 well installation technologies to be used. In reality not all of the technologies would be usable at this site as there are lenses of cemented material which stop the less-robust methods (direct push and hollow stem auger). Direct push and hollow stem rigs can also be subject to depth limitations even in geologic formations that otherwise are suitable.
- It was assumed that all of the drilling technologies included in this study would be available for use. This is another assumption that will usually not be the case since some rigs are more commonly used (cable tool, mud rotary, and hollow stem auger) and others are not as common (direct push and sonic). For the less common drill rigs, there may be greater mobilization distances which would increase the environmental impact of using these drill rigs.
- The rate of well completion is used frequently to calculate the amount of time that equipment and personnel spend on-site. It includes the time to drill, install, and develop the well.
- Another concept of note is IDW generation. For each well installation method, the amount of IDW generated is expressed as number of barrels per foot. This includes drill cuttings, development water, and in the case of mud rotary drilling, drilling mud.
- Three-man crews were used for all drilling methods modeled, including direct push.

To complete the study, the inputs that are described in the tables below were entered into SiteWise™ version 2 as five different alternatives. Once all of the alternatives were entered, comparisons of the different alternatives were generated in SiteWise™. At the end of this report, tables and graphs are included showing the impacts of each method. Also included is a qualitative comparison of the different methods that further explains the results.

DRILLING	**Event 1**
Number of Drilling Locations	5
Drilling Method	Sonic
Days Spent at Site	8
Time spent drilling at each location (hr)[1]	15.4
Depth of wells (ft)[2]	80
Fuel type	Diesel
[1]The rate for well completion using sonic drilling is 52 ft/day (Masten and Davis). In that study 10 hour work days were used, which is also the case for the drilling that is being performed at the Site. [2]The depth of the wells is an assumed value based on the specification that wells would be drilled ten feet below the top of the water table, which is at 70 feet bgs.	

PERSONNEL TRANSPORTATION - ROAD	**Vehicle 1**	**Vehicle 2**	**Vehicle 3**
Trip Description	Rig Mob/Demob	Truck Mob/Demob	Mob/Demob + Daily Trips
Will DIESEL-run vehicles be retrofitted with a particulate reduction technology?	No	No	No
Vehicle type	Heavy Duty	Heavy Duty	Light Truck
Fuel	Diesel	Diesel	Gasoline
Distance traveled per trip (miles)[1]	340	340	340 (mob/demob), 10 (daily trips)
Number of trips taken	1	1	2 (mob/demob)[2], 16 (daily trips)
Number of travelers	1	1	1 (mob/demob), 3 (daily trips)
For equipment/personnel mobilization, it is assumed that three vehicles mobilize to the site. Included are the drill rig and support truck (both modeled as heavy duty trucks) and a light truck carrying other miscellaneous equipment. The drill rig and support truck stay at the Site for the duration of the drilling while the light truck is used to transport personnel between the site and hotels/restaurants. [1]Vehicles mobilize from Kansas City which is 170 miles from the Site. Daily trips in Vehicle 3 are between the Site and a town approximately five miles away. All mileage is round trip. [2] Since drilling would take longer than one week (crews only drill four days per week because of site resident restrictions and eight days of drilling are required), a second trip between the Site and Kansas City would occur to allow personnel to return to Kansas City over the weekend.			

EQUIPMENT TRANSPORTATION – ROAD[1]	Trip 1	Trip 2	Trip 3	Trip 4
Short Description of Trip	IDW Barrel Delivery	IDW Barrel Delivery (empty return)	IDW Barrel Pickup (empty departing)	IDW Barrel Pickup
Will DIESEL-run vehicles be retrofitted with a particulate reduction technology?	No	No	No	No
Fuel	Diesel	Diesel	Diesel	Diesel
Distance traveled (miles)	170	170	170	170
Weight of equipment transported (tons)	0.24	0.00	0.00	4.32

[1]In SiteWise V2, the disposal of IDW could be input in the "Residue Disposal" table. In actuality, either the "Residue Disposal" table or the "Equipment Transportation-Road" table can be used since both tables require the same input information and calculate environmental impact using the same algorithm; therefore, the choice of which table to use is arbitrary.
All IDW generated on site is assumed to be transported to a landfill in Kansas City for disposal.
The assumption is made that an on-road truck (semi-trailer) would bring all of the IDW barrels to the Site. Weights of IDW barrels are 40 lbs when empty and 920 lbs when filled with drill cuttings or 500 lbs when filled with equipment decontamination waste. The weight of equipment transported is based on the volume of IDW generated by the sonic drilling. The Masten and Davis study reported an IDW generation of 1 barrel for every 60 feet of drilling plus 1 barrel of decontamination waste per well.

LANDFILL OPERATIONS	Operation 1
Choose landfill type for waste disposal	Non-Hazardous
Input amount of waste disposed in landfill (tons)	4.32

OPERATOR LABOR	Occupation 1
Occupation	Construction Laborers
Input total time worked onsite (hours)	230

Time spent working is calculated based on the time that it takes to complete all of the wells. It is assumed that there are three workers on a sonic drill crew, and they each work ten hour days. The days worked are not rounded up to the next whole day since SiteWise calculates accident and injury risk based on operator labor. Hence if it takes 2.5 days to install all wells, that means that while the crews may be at the site for 3 days, they will only be working with equipment for 2.5 of those days.

Materials calculations are based on an assumed well that has a boring depth of 80 feet (this is similar to the existing monitoring well located on-site). A six inch inside diameter boring is drilled using the specific drilling method for this section. A 2” inner PVC pipe runs the length of the boring and a 6” steel casing protects the upper 4 feet. Sand fills the annular space in the lower 15 feet of the boring and a bentonite grout fills the rest of the annular space. The well is completed with a cement flush mount.

WELL MATERIALS	**Inner PVC Casing**	**Outer Steel Casing**
Input number of wells	5	5
Input length of casing (ft)	80	4
Material Schedule	Sch 40 PVC	Sch 40 Steel
Well diameter (inches)	2	6
SiteWise calculates material usage based on pounds of piping per linear foot. The PVC casing is assumed to run the entire length of the boring from the top of casing to the bottom of the screen (this is slightly simplified since the screened interval would have slotted PVC instead of solid PVC). Steel casings are assumed to go four feet below ground surface, which is approximately the frost line distance.		

BULK MATERIAL QUANTITIES	**Material 1**	**Material 2**	**Material 3**
Choose material from drop down menu	Sand	Bentonite Grout	Cement
Choose units of material quantity from drop down menu	pounds	pounds	Pounds
Input material quantity	157	654.5	416
Weight of sand is based on an assumed unit weight of 120 lbs per cubic foot. Bentonite is assumed to be 100 lbs per cubic foot and cement is 150 lbs per cubic foot.			

DRILLING	**Event 1**
Number of Drilling Locations	5
Drilling Method	Direct Push
Days Spent at Site	2
Time spent drilling at each location (hr)[1]	3.2
Depth of wells (ft)[2]	80
Fuel type	Diesel

[1]The rate for well completion using direct push well installation is 250 ft/day (ESTCP 2009). No information was given concerning whether the work days were 8 or 10 hours, so 10 hour work days were assumed.
[2]The depth of the wells is an assumed value based on the specification that wells would be drilled ten feet below the top of the water table, which is at 70 feet bgs.

PERSONNEL TRANSPORTATION - ROAD	**Vehicle 1**	**Vehicle 2**	**Vehicle 3**
Short Trip Description	Rig Mob/Demob	Truck Mob/Demob	Mob/Demob + Daily Trips
Will DIESEL-run vehicles be retrofitted with a particulate reduction technology?	No	No	No
Vehicle type	Light Truck	Light Truck	Light Truck
Fuel	Gasoline	Gasoline	Gasoline
Distance traveled per trip (miles)[1]	340	340	340 (mob/demob), 10 (daily trips)
Number of trips taken	1	1	1 (mob/demob), 4 (daily trips)
Number of travelers	1	1	1 (mob/demob), 3 (daily trips)

For equipment/personnel mobilization it is assumed the three vehicles mobilize to the site. Included are the vehicle carrying the direct push probe, a supporting vehicle carrying drill rods and other drilling equipment, and a light truck carrying other items and personal supplies for the drillers (all modeled as light trucks). The truck carrying the direct push probe as well as the support truck both stay on Site for the duration of the drilling while the light truck is used to transport personnel between the site and hotels/restaurants.
[1]Vehicles mobilize from Kansas City which is 170 miles from the Site. Daily trips in Vehicle 3 are between the Site and a town approximately five miles away. All mileage is round trip.

EQUIPMENT TRANSPORTATION – ROAD[1]	Trip 1	Trip 2	Trip 3	Trip 4
Short Description of Trip	IDW Barrel Delivery	IDW Barrel Delivery (empty return)	IDW Barrel Pickup (empty departing)	IDW Barrel Pickup
Will DIESEL-run vehicles be retrofitted with a particulate reduction technology?	No	No	No	No
Fuel	Diesel	Diesel	Diesel	Diesel
Distance traveled (miles)	170	170	170	170
Weight of equipment transported (tons)	0.12	0.00	0.00	1.52

[1]In SiteWise V2, the disposal of IDW could be input in the "Residue Disposal" table. In actuality, either the "Residue Disposal" table or the "Equipment Transportation-Road" table can be used since both tables require the same input information and calculate environmental impact using the same algorithm; therefore, the choice of which table to use is arbitrary.
All IDW generated on site is assumed to be transported to a landfill in Kansas City for disposal.
The assumption is made that an on-road truck (semi-trailer) would bring all of the IDW barrels to the Site. Weights of IDW barrels are 40 lbs when empty and 920 lbs when filled with drill cuttings or 500 lbs when filled with equipment decontamination waste. The weight of equipment transported is based on the volume of IDW generated by the direct push well installation. The ESTCP study (ESTCP 2009) reported an IDW generation of 1 barrel for every 66 feet of drilling.

LANDFILL OPERATIONS	Operation 1
Choose landfill type for waste disposal	Non-Hazardous
Input amount of waste disposed in landfill (tons)	1.52

OPERATOR LABOR	Occupation 1
Occupation	Construction Laborers
Input total time worked onsite (hours)	48

Time spent working is calculated based on the time that it takes to complete all of the wells. It is assumed that there are three workers on a direct push well installation crew, and they each work ten hour days. The days worked are not rounded up to the next whole day since SiteWise calculates accident and injury risk based on operator labor. Hence if it takes 2.5 days to install all wells, that means that while the crews may be at the site for 3 days, they will only be working with equipment for 2.5 of those days.

Materials calculations are based on an assumed well that has a boring depth of 80 feet (this is similar to the existing monitoring well located on-site). A 4.25" drive rod is used to clear the boring, and a 2" PVC pipe runs from the screen to the surface. Similar to the "conventional" well installation methods, a 6" steel casing protects the PVC pipe above the frost line. Sand fills the annular space (which is smaller for direct push wells) for the lower 15' of the boring and bentonite grout fills the remaining annular space. The well is completed with a cement flush mount. It is again worth noting that the assumption of using direct push to install a 4.25" diameter 80' deep well would not be feasible in all subsurface conditions.

WELL MATERIALS	**Inner PVC Casing**	**Outer Steel Casing**
Input number of wells	5	5
Input length of casing (ft)	80	4
Material Schedule	Sch 40 PVC	Sch 40 Steel
Well diameter (inches)	2	6
SiteWise calculates material usage based on pounds of piping per linear foot. The PVC casing is assumed to run the entire length of the boring from the top of casing to the bottom of the screen (this is slightly simplified since the screened interval would have slotted PVC instead of solid PVC). Steel casings are assumed to go four feet below ground surface, which is approximately the frost line distance.		

BULK MATERIAL QUANTITIES	**Material 1**	**Material 2**	**Material 3**
Choose material from drop down menu	Sand	Bentonite Grout	Cement
Choose units of material quantity from drop down menu	Pounds	pounds	pounds
Input material quantity	49.7	207	416
Weight of sand is based on an assumed unit weight of 120 lbs per cubic foot. Bentonite is assumed to be 100 lbs per cubic foot and cement is 150 lbs per cubic foot.			

DRILLING	Event 1
Number of Drilling Locations	5
Drilling Method	Cable Tool[1]
Days Spent at Site	21
Time spent drilling at each location (hr)[2]	41
Depth of wells (ft)[3]	80
Fuel type	Diesel

[1] Since SiteWise does not include cable tool rigs as one of the available drilling technologies, external research was done to determine a fuel consumption rate of 0.7 gallons per hour (http://scribd.com/doc/29443476/Cable-Tool-Drilling)
[2]The rate for well completion using cable tool drilling is 19.5 ft/day (Masten and Davis). In that study 10 hour work days were used, which is also the case for the drilling that is being performed at the Site.
[3]The depth of the wells is an assumed value based on the specification that wells would be drilled ten feet below the top of the water table, which is at 70 feet bgs.

PERSONNEL TRANSPORTATION - ROAD	Vehicle 1	Vehicle 2	Vehicle 2
Short Trip Description	Rig Mob/Demob	Truck Mob/Demob	Mob/Demob +Truck Daily Trips
Will DIESEL-run vehicles be retrofitted with a particulate reduction technology?	No	No	No
Vehicle type	Heavy Duty	Heavy Duty	Light Truck
Fuel	Diesel	Diesel	Gasoline
Distance traveled per trip (miles)[1]	340	340	340 (mob/demob), 10 (daily trips)
Number of trips taken	1	1	5 (mob/demob)[2], 42 (daily trips)
Number of travelers	1	1	1 (mob/demob), 3 (daily trips)

For equipment/personnel mobilization, it is assumed that three vehicles mobilize to the site. Included are the drill rig and support truck (both modeled as heavy duty trucks) and a light truck carrying other miscellaneous equipment. The drill rig and support truck stay at the Site for the duration of the drilling while the light truck is used to transport personnel between the site and hotels/restaurants.
[1]Vehicles mobilize from Kansas City which is 170 miles from the Site. Daily trips in the pickup are between the Site and a town approximately five miles away. All mileage is round trip.
[2] Since drilling would take longer than one week (crews only drill four days per week because of site resident restrictions, and twenty one days are required for drilling), five total trips between the Site and Kansas City would occur to allow personnel to return to Kansas City over the weekends.

EQUIPMENT TRANSPORTATION – ROAD[1]	**Trip 1**	**Trip 2**	**Trip 3**	**Trip 4**
Short Description of Trip	IDW Barrel Delivery	IDW Barrel Delivery (empty return)	IDW Barrel Pickup (empty departing)	IDW Barrel Pickup
Will DIESEL-run vehicles be retrofitted with a particulate reduction technology?	No	No	No	No
Fuel	Diesel	Diesel	Diesel	Diesel
Distance traveled (miles)	170	170	170	170
Weight of equipment transported (tons)	0.24	0.00	0.00	4.32

[1]In SiteWise V2, the disposal of IDW could be input in the "Residue Disposal" table. In actuality, either the "Residue Disposal" table or the "Equipment Transportation-Road" table can be used since both tables require the same input information and calculate environmental impact using the same algorithm; therefore, the choice of which table to use is arbitrary.
All IDW generated on site is assumed to be transported to a landfill in Kansas City for disposal.
The assumption is made that an on-road truck (semi-trailer) would bring all of the IDW barrels to the Site. Weights of IDW barrels are 40 lbs when empty and 920 lbs when filled with drill cuttings or 500 lbs when filled with equipment decontamination waste. The weight of equipment transported is based on the volume of IDW generated by the sonic drilling. The Masten and Davis study reported an IDW generation of 1 barrel for every 60 feet of drilling plus 1 barrel of decontamination waste per well.

LANDFILL OPERATIONS	**Operation 1**
Choose landfill type for waste disposal	Non-Hazardous
Input amount of waste disposed in landfill (tons)	4.32

OPERATOR LABOR	**Occupation 1**
Occupation	Construction Laborers
Input total time worked onsite (hours)	615

Time spent working is calculated based on the time that it takes to complete all of the wells. It is assumed that there are three workers on a cable tool drill crew, and they each work ten hour days. The days worked are not rounded up to the next whole day since SiteWise calculates accident and injury risk based on operator labor. Hence if it takes 2.5 days to install all wells, that means that while the crews may be at the site for 3 days, they will only be working with equipment for 2.5 of those days.

Materials calculations are based on an assumed well that has a boring depth of 80 feet (this is similar to the existing monitoring well located on-site). A six inch inside diameter boring is drilled using the specific drilling method for this section. A 2" inner PVC pipe runs the length of the boring and a 6" steel casing protects the upper 4 feet. Sand fills the annular space in the lower 15 feet of the boring and a bentonite grout fills the rest of the annular space. The well is completed with a cement flush mount.

WELL MATERIALS	**Inner PVC Casing**	**Outer Steel Casing**
Input number of wells	5	5
Input length of casing (ft)	80	4
Material Schedule	Sch 40 PVC	Sch 40 Steel
Well diameter (inches)	2	6
SiteWise calculates material usage based on pounds of piping per linear foot. The PVC casing is assumed to run the entire length of the boring from the top of casing to the bottom of the screen (this is slightly simplified since the screened interval would have slotted PVC instead of solid PVC). Steel casings are assumed to go four feet below ground surface, which is approximately the frost line distance.		

BULK MATERIAL QUANTITIES	**Material 1**	**Material 2**	**Material 3**
Choose material from drop down menu	Sand	Bentonite Grout	Cement
Choose units of material quantity from drop down menu	pounds	pounds	pounds
Input material quantity	157	654.5	416
Weight of sand is based on an assumed unit weight of 120 lbs per cubic foot. Bentonite is assumed to be 100 lbs per cubic foot and cement is 150 lbs per cubic foot.			

DRILLING	**Event 1**
Number of Drilling Locations	5
Drilling Method	Mud Rotary
Days Spent at Site	8
Time spent drilling at each location (hr)[1]	14.5
Depth of wells (ft)[2]	80
Fuel type	Diesel

[1]The rate for well completion using mud rotary drilling is 55 ft/day (Masten and Davis). In that study 10 hour work days were used, which is also the case for the drilling that is being performed at the Site.
[2]The depth of the wells is an assumed value based on the specification that wells would be drilled ten feet below the top of the water table, which is at 70 feet bgs.

PERSONNEL TRANSPORTATION - ROAD	**Vehicle 1**	**Vehicle 2**	**Vehicle 3**
Short Trip Description	Rig Mob/Demob	Truck Mob/Demob	Mob/Demob + Daily Trips
Will DIESEL-run vehicles be retrofitted with a particulate reduction technology?	No	No	No
Vehicle type	Heavy Duty	Heavy Duty	Light Truck
Fuel	Diesel	Diesel	Gasoline
Distance traveled per trip (miles)[1]	340	340	340 (mob/demob), 10 (daily trips)
Number of trips taken	1	1	2 (mob/demob)[2], 16 (daily trips)
Number of travelers	1	1	1 (mob/demob), 3 (daily trips)

For equipment/personnel mobilization, it is assumed that three vehicles mobilize to the site. Included are the drill rig and water/support truck (both modeled as heavy duty trucks) and a light truck carrying other miscellaneous equipment. The drill rig and support truck stay at the Site for the duration of the drilling while the light truck is used to transport personnel between the site and hotels/restaurants.
[1]Vehicles mobilize from Kansas City which is 170 miles from the Site. Daily trips in the pickup are between the Site and a town approximately five miles away. All mileage is round trip.
[2] Since drilling would take longer than one week (crews only drill four days per week due to site resident restrictions and eight days of drilling are needed), a second trip between the Site and Kansas City would occur to allow personnel to return to Kansas City over the weekend.

LANDFILL OPERATIONS	**Operation 1**
Choose landfill type for waste disposal	Non-Hazardous
Input amount of waste disposed in landfill (tons)	43

EQUIPMENT TRANSPORTATION – ROAD[1]	Trip 1	Trip 2	Trip 3	Trip 4
Short Description of Trip	IDW Barrel Delivery	IDW Barrel Delivery (empty return)	IDW Barrel Pickup (empty departing)	IDW Barrel Pickup[2]
Will DIESEL-run vehicles be retrofitted with a particulate reduction technology?	No	No	No	No
Fuel (gasoline, diesel)	Diesel	Diesel	Diesel	Diesel
Distance traveled (miles)	170	170	170	170
Weight of equipment transported (tons)	3.72	0.00	0.00	43

[1]In SiteWise V2, the disposal of IDW could be input in the "Residue Disposal" table. In actuality, either the "Residue Disposal" table or the "Equipment Transportation-Road" table can be used since both tables require the same input information and calculate environmental impact using the same algorithm; therefore, the choice of which table to use is arbitrary.
All IDW generated on site is assumed to be transported to a landfill in Kansas City for disposal.
The assumption is made that an on-road truck (semi-trailer) would bring all of the IDW barrels to the Site. Weights of IDW barrels are 40 lbs when empty and 920 lbs when filled with drill cuttings. The weight of equipment transported is based on the volume of IDW generated by the mud rotary drilling. The Masten and Davis study reported an IDW generation of 1 barrel for every 2.15 feet of drilling. Assuming that this includes all of the recovered drilling fluids and all of the water extracted for well development, for 400 feet of drilling this would calculate to 186 barrels. Since the barrels are primarily filled water, the weight of the barrels is calculated assuming they are filled with water only.
[2]The total amount of IDW generated would be 43 tons. However, the method that SiteWise uses to calculate fuel economy of an on-road truck does not accept equipment weights greater than 40 tons, so the load has to be distributed between two trips, each with weight of 21.5 tons.

OPERATOR LABOR	Occupation 1
Occupation	Construction Laborers
Input total time worked onsite (hours)	218

Time spent working is calculated based on the time that it takes to complete all of the wells. It is assumed that there are three workers on a mud rotary drill crew, and they each work ten hour days. The days worked are not rounded up to the next whole day since SiteWise calculates accident and injury risk based on operator labor. Hence if it takes 2.5 days to install all wells, that means that while the crews may be at the site for 3 days, they will only be working with equipment for 2.5 of those days.

WATER CONSUMPTION	Drilling Mud Make-up Water
Input total water consumed from potable water treatment facility (gal)	10000

Water consumption is based on the amount of water needed to make up the drilling mud used during drilling. The Masten and Davis study states

that “several thousand” gallons of drilling mud may be needed. It was assumed that each boring would require 2000 gallons of drilling mud

Materials calculations are based on an assumed well that has a boring depth of 80 feet (this is similar to the existing monitoring well located on-site). A six inch inside diameter boring is drilled using the specific drilling method for this section. A 2” inner PVC pipe runs the length of the boring and a 6” steel casing protects the upper 4 feet. Sand fills the annular space in the lower 15 feet of the boring and a bentonite grout fills the rest of the annular space. The well is completed with a cement flush mount.

WELL MATERIALS	**Inner PVC Casing**	**Outer Steel Casing**
Input number of wells	5	5
Input length of casing (ft)	80	4
Material Schedule	Sch 40 PVC	Sch 40 Steel
Well diameter (inches)	2	6
SiteWise calculates material usage based on pounds of piping per linear foot. The PVC casing is assumed to run the entire length of the boring from the top of casing to the bottom of the screen (this is slightly simplified since the screened interval would have slotted PVC instead of solid PVC). Steel casings are assumed to go four feet below ground surface, which is approximately the frost line distance.		

BULK MATERIAL QUANTITIES	**Material 1**	**Material 2**	**Material 3**
Choose material from drop down menu	Sand	Bentonite Grout	Cement
Choose units of material quantity from drop down menu	pounds	pounds	pounds
Input material quantity	157	654.5	416
Weight of sand is based on an assumed unit weight of 120 lbs per cubic foot. Bentonite is assumed to be 100 lbs per cubic foot and cement is 150 lbs per cubic foot.			

DRILLING	Event 1
Number of Drilling Locations	5
Drilling Method	Hollow Stem Auger
Days Spent at Site	7
Time spent drilling at each location (hr)[1]	13.33
Depth of wells (ft)[2]	80
Fuel type	Diesel

[1]The rate for well completion using hollow stem auger drilling is 60 ft/day (ESTCP 2009). No information was given concerning whether the work days were 8 or 10 hours, so 10 hour work days were assumed.
[2]The depth of the wells is an assumed value based on the specification that wells would be drilled ten feet below the top of the water table, which is at 70 feet bgs.

PERSONNEL TRANSPORTATION - ROAD	Vehicle 1	Vehicle 2	Vehicle 3
Short Trip Description	Rig Mob/Demob	Truck Mob/Demob	Mob/Demob + Daily Trips
Will DIESEL-run vehicles be retrofitted with a particulate reduction technology?	No	No	No
Vehicle type	Heavy Duty	Heavy Duty	Light Truck
Fuel	Diesel	Diesel	Gasoline
Distance traveled per trip (miles)[1]	340	340	340 (mob/demob), 10 (daily trips)
Number of trips taken	1	1	2 (mob/demob)[2], 14 (daily trips)
Number of travelers	1	1	1 (mob/demob), 3 (daily trips)

For equipment/personnel mobilization, it is assumed that three vehicles mobilize to the site. Included are the drill rig and support truck (both modeled as heavy duty trucks) and a light truck carrying other miscellaneous equipment. The drill rig and support truck stay at the Site for the duration of the drilling while the light truck is used to transport personnel between the site and hotels/restaurants.
[1]Vehicles mobilize from Kansas City which is 170 miles from the Site. Daily trips in the pickup are between the Site and a nearby town approximately five miles away. All mileage is round trip.
[2] Since drilling would take longer than one week (crews only drill four days per week due to site resident restrictions, and seven days of drilling are needed), a second trip between the Site and Kansas City would occur to allow personnel to return home over the weekend.

EQUIPMENT TRANSPORTATION – ROAD[1]	**Trip 1**	**Trip 2**	**Trip 3**	**Trip 4**
Short Description of Trip	IDW Barrel Delivery	IDW Barrel Delivery (empty return)	IDW Barrel Pickup (empty departing)	IDW Barrel Pickup
Will DIESEL-run vehicles be retrofitted with a particulate reduction technology?	No	No	No	No
Fuel (gasoline, diesel)	diesel	diesel	diesel	diesel
Distance traveled (miles)	170	170	170	170
Weight of equipment transported (tons)	0.4	0.00	0.00	8.06

[1]In SiteWise V2, the disposal of IDW could be input in the "Residue Disposal" table. In actuality, either the "Residue Disposal" table or the "Equipment Transportation-Road" table can be used since both tables require the same input information and calculate environmental impact using the same algorithm; therefore, the choice of which table to use is arbitrary.
All IDW generated on site is assumed to be transported to a landfill in Kansas City for disposal.
The assumption is made that an on-road truck (semi-trailer) would bring all of the IDW barrels to the Site. Weights of IDW barrels are 40 lbs when empty and 920 lbs when filled with drill cuttings or 500 lbs when filled with equipment decontamination waste. The weight of equipment transported is based on the volume of IDW generated by the hollow stem auger drilling. The Masten and Davis study reported an IDW generation of 1 barrel for every 27 feet of drilling plus 1 barrel of decontamination waste per well.

LANDFILL OPERATIONS	**Operation 1**
Choose landfill type for waste disposal	Non-Hazardous
Input amount of waste disposed in landfill (tons)	8.06

OPERATOR LABOR	**Occupation 1**
Occupation	Construction Laborers
Input total time worked onsite (hours)	200

Time spent working is calculated based on the time that it takes to complete all of the wells. It is assumed that there are three workers on a hollow stem auger drill crew, and they each work ten hour days. The days worked are not rounded up to the next whole day since SiteWise calculates accident and injury risk based on operator labor. Hence if it takes 2.5 days to install all wells, that means that while the crews may be at the site for 3 days, they will only be working with equipment for 2.5 of those days.

Materials calculations are based on an assumed well that has a boring depth of 80 feet (this is similar to the existing monitoring well located on-site). A six inch inside diameter boring is drilled using the specific drilling method for this section. A 2” inner PVC pipe runs the length of the boring and a 6” steel casing protects the upper 4 feet. Sand fills the annular space in the lower 15 feet of the boring and a bentonite grout fills the rest of the annular space. The well is completed with a cement flush mount.

WELL MATERIALS	**Inner PVC Casing**	**Outer Steel Casing**
Input number of wells	5	5
Input length of casing (ft)	80	4
Material Schedule	Sch 40 PVC	Sch 40 Steel
Well diameter (inches)	2	6
SiteWise calculates material usage based on pounds of piping per linear foot. The PVC casing is assumed to run the entire length of the boring from the top of casing to the bottom of the screen (this is slightly simplified since the screened interval would have slotted PVC instead of solid PVC). Steel casings are assumed to go four feet below ground surface, which is approximately the frost line distance.		

BULK MATERIAL QUANTITIES	**Material 1**	**Material 2**	**Material 3**
Choose material from drop down menu	Sand	Bentonite Grout	Cement
Choose units of material quantity from drop down menu	pounds	pounds	pounds
Input material quantity	157	654.5	416
Weight of sand is based on an assumed unit weight of 120 lbs per cubic foot. Bentonite is assumed to be 100 lbs per cubic foot and cement is 150 lbs per cubic foot.			

Summary of Results

Once all of the different scenarios described in the tables above were entered into SiteWise V2, the Final Summary spreadsheet could be created. Results are presented in two forms.

- Method One: The first method shows the results generated in SiteWise by entering the inputs for each drilling technique exactly as they are documented in the tables above. This form of results represents a traditional footprint calculation which includes all of the activities related with installing the 5 wells.
- Method Two: The second method of reporting the results is to display them on a “per well basis”. By presenting the results in this fashion, readers can apply the results from the case study to other sites where the number of wells being installed is different from that of the case study. It should be noted that the impact of installing one well was determined by creating scenarios in which a single well was installed using each different drilling method. This means that the results from Method Two are not simply equal to one fifth of the results from Method One (since 5 wells were installed). Multiplying Method Two values by the number of wells in Method One would produce answers that are higher than the results from Method One. This factors in economy of scale (impact per well goes down as the number of wells installed increases). Another important note is that mobilization and demobilization were stripped from the individual well footprint calculations. A single mob/demob event was calculated so the reader can choose at their discretion how many mobilization trips would be required to install any number of wells.

General Discussion of Results

The results indicate that mud rotary drilling has the greatest environmental impact followed by hollow stem, sonic, cable tool, and direct push. What this indicates is that the fuel consumed by the drill rig represents the largest driver of environmental impact. Drill rigs such as mud rotary, hollow stem, and sonic had significantly better drilling rates than cable tool, but their fuel consumption was disproportionately greater.

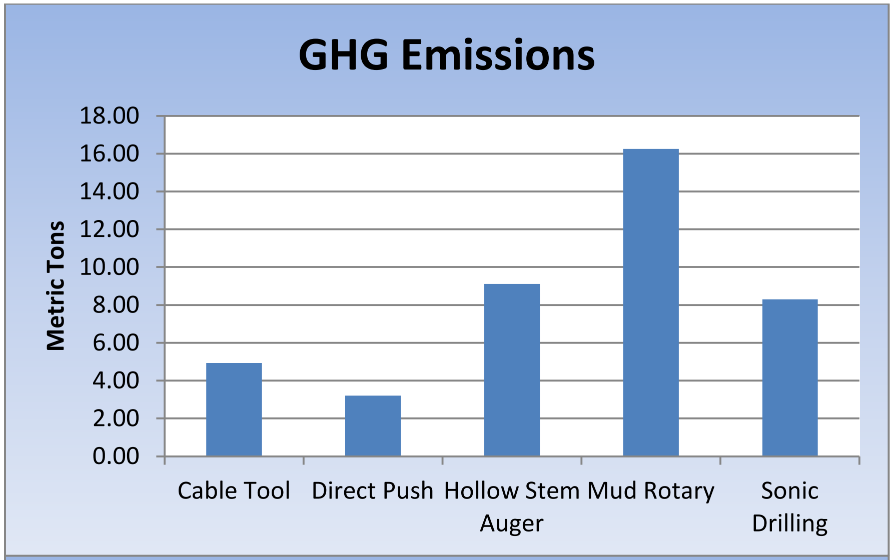
The results from this case study should only be accepted in a qualitative manner when considering well installation at other sites. The amount of variance between the assumptions in the case study and real world values will almost always be different.

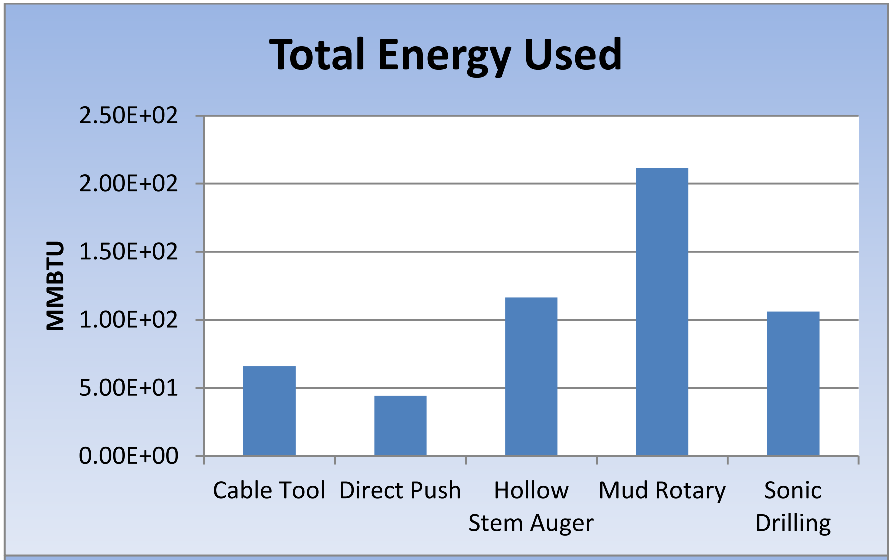
Also, this case study does not represent an endorsement of one drilling technology versus another. While the results do indicate that certain drilling techniques have GSR advantages, GSR represents only one of the considerations that should be made when selecting a drilling method. Other limiting factors can include cost, site geology, equipment availability, etc.

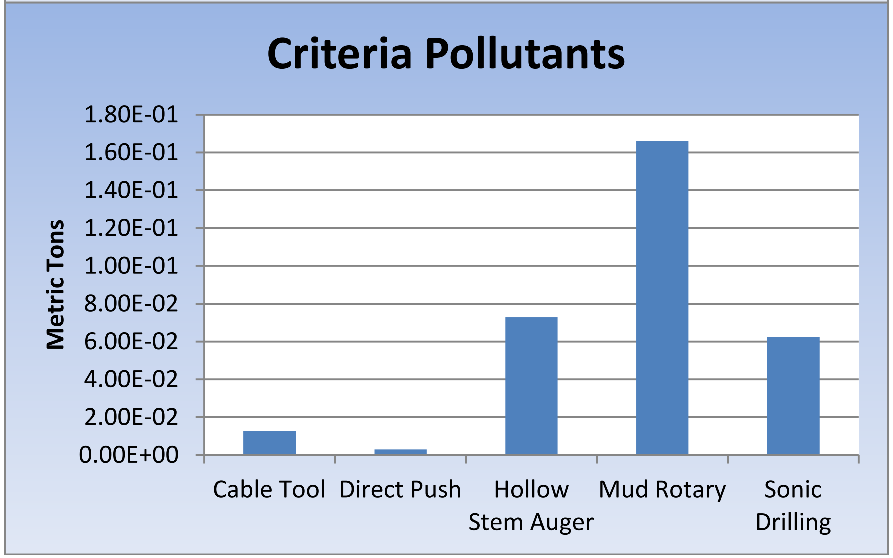
GSR Parameter	Method One (includes Mob/Demob) Cable Tool	Direct Push	Hollow Stem	Mud Rotary	Sonic
Environmental					
Energy (MMBtu)	65.93	44.20	116.36	217.84	106.15
Global warming potential (Metric tons CO2e)	4.937	3.208	9.114	16.753	8.300
Criteria air pollutant emissions (Metric tons NOx+SOx+PM10)	0.013	0.003	0.073	0.166	0.062
Water Use (gallons)	0.000	0.000	0.000	10000.000	0.000
Non-hazardous waste generation (tons)	4.320	1.520	8.060	85.600	4.320
Hazardous waste generation (tons)	0.000	0.000	0.000	0.000	0.000
Economic					
Up-front Cost					
Societal					
Injury or fatality risk	1.97E-02	2.63E-03	7.72E-03	8.53E-03	8.69E-03
Predicted number of hours lost to injury	1.57E-01	2.09E-02	6.14E-02	6.78E-02	6.91E-02

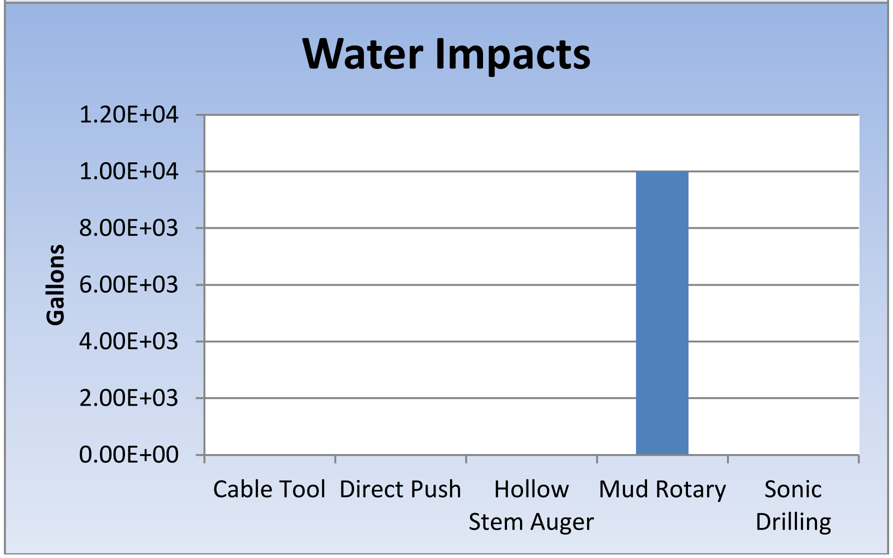
	Method Two (Mob/Demob Separate)					Mob/Demob	
GSR Parameter	**Cable Tool**	**Direct Push**	**Hollow Stem**	**Mud Rotary**	**Sonic**	**Direct Push**	**Other Methods**
Environmental							
Energy (MMBtu)	18.28	15.94	29.89	54.74	27.83	7.09	14.85
Global warming potential (Metric tons CO2e)	1.37	1.18	2.33	4.20	2.16	0.56	1.14
Criteria air pollutant emissions (Metric tons NOx+SOx+PM10)	0.00	0.00	0.01	0.03	0.01	<0.005	<0.005
Water Use (gallons)	0.00	0.00	0.00	2000.00	0.00	0.00	0.00
Non-hazardous waste generation (tons)	0.86	0.30	1.61	17.12	0.86	0.00	0.00
Hazardous waste generation (tons)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Economic							
Up-front Cost							
Societal							
Injury or fatality risk	3.98E-03	7.66E-04	1.74E-03	2.06E-03	1.93E-03	1.94E-03	6.48E-04
Predicted number of hours lost to injury	3.17E-02	6.07E-03	1.38E-02	1.64E-02	1.54E-02	1.54E-02	5.12E-03

Method One Charts

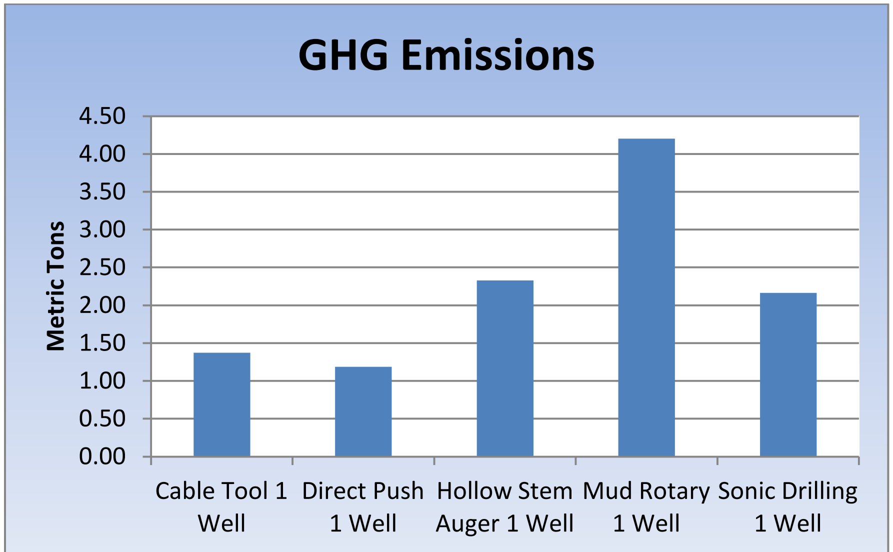


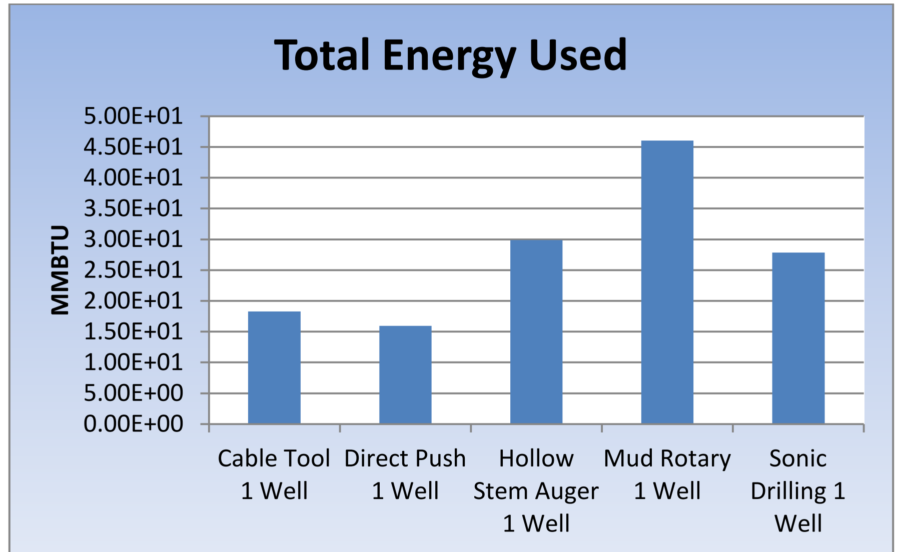


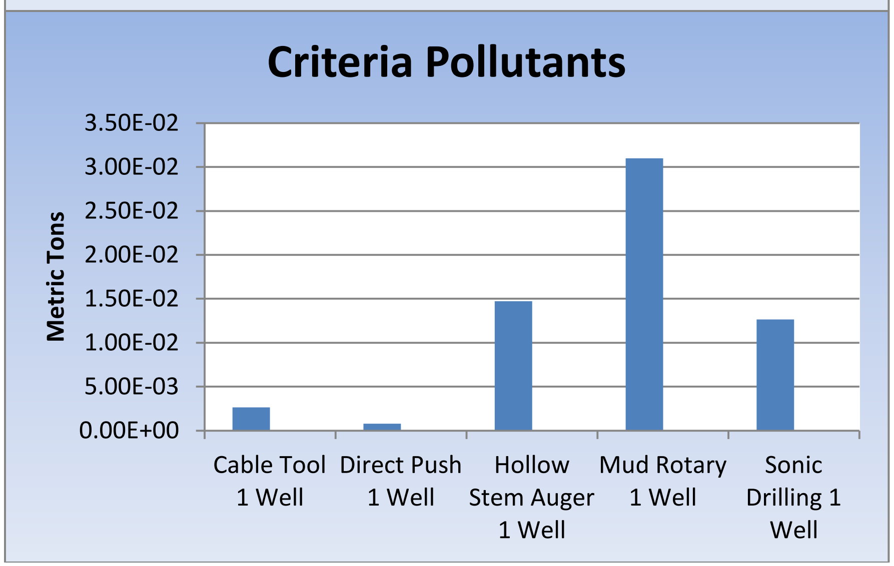


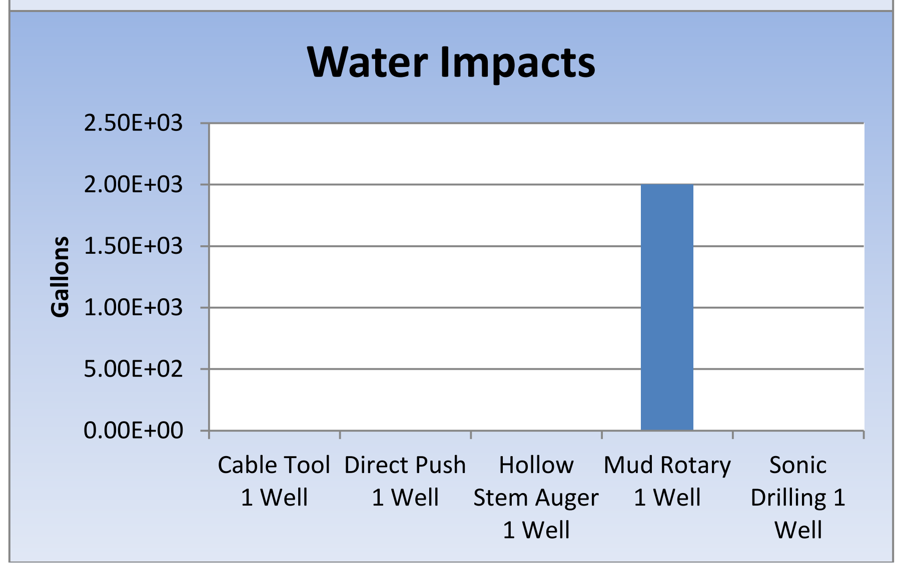


Method Two Charts









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Appendix C3

Case Study Case Study of Comparative Impacts of Low-Flow Sampling vs. Passive Diffusion Bag Sampling
Joint Base Lewis-McChord , Washington
(to be used as a general reference on further Site investigation and other SI/RI investigations)

U.S. Army
Green and Sustainable Remediation (GSR)
Case Study

Comparison of Low Flow vs. Passive Diffusion Bag Sampling

Joint Base Lewis-McChord WASHINGTON

This case study briefly summarizes a Green and Sustainable Remediation (GSR) practice that has been applied at this site and can be implemented at many sites that currently use low flow sampling. GSR practices which are implemented in this case study include:

- Planning for sustainability
- Energy/emission reductions
- Water resource conservation
- Reduction of materials use and waste generation
- Improvements related to safety and community

The monitoring program for pump and treat (P&T) systems at Joint Base Lewis-McChord (JBLM) was used as a case study to compare the relative impact of using passive diffusion bag (PDB) sampling as opposed to low flow sampling. Currently, 61 wells are sampled for volatile organic compounds (with 56 of them using PDBs for sample collection). The case study compared two scenarios in which sampling was performed either completely by PDBs or completely by low flow sampling.

Footprint reduction from using PDBs is driven by the reduced time spent in the field. A two person team can sample 12 wells per day using PDBs while only being able to sample 5 wells per day using low flow methods. More days in the field translates to more vehicle miles, higher accident risk, and more energy and equipment use. Annual impact reductions are summarized as follows:

- **A 54% reduction in GHG emissions using PDBs**
- **A 55% reduction of energy used using PDBs**
- **A 63% reduction in Criteria Air Pollutant Emissions using PDBs**
- **A 59% reduction in accident injury or fatality risk using PDBs**

For more information, contact
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https://casi.erdc.usace.army.mil/focusareas/green_remediation/?contentRegion=Item&id=62056

September 2011

Case Study of Comparative Impacts of Low-Flow Sampling vs. Passive Diffusion Bag Sampling

Joint Base Lewis-McChord

This case study was performed to compare the environmental footprint of low flow sampling (LFS) versus passive diffusion bag (PDB) sampling at Joint Base Lewis-McChord (JBLM). JBLM is located in northwest Washington approximately 30 miles south of Seattle. Contamination is due to a 23 acre industrial landfill that had been actively used in the past. The primary contaminants of concern (COCs) are volatile organic compounds such as trichloroethene (TCE). Treatment consists of three separate pump and treat systems. Monitoring of the treatment systems is accomplished by sampling for COCs and water levels from 61 wells, 56 of which are sampled by PDBs and 5 by low flow sampling. An operations and maintenance staff located on the site performs all of the sample collection.

The case study was performed by developing two unique scenarios in which well samples were assumed to be collected either by PDBs only or LFS only. Quantitative analysis of environmental footprint was performed using SiteWise™ version 2 (SiteWise™ (available at http://www.ert2.org/t2gsrportal/SiteWise.aspx). Detailed assumptions and calculations are addressed in the tables included in this report. Information that is not formally referenced was obtained from the installation as part of a larger body of information collected for performance of a Remediation System Evaluation (RSE) on the installation. See USACE and Tetratech Geo (2011) for more details.

Some general assumptions used during the analysis are:

- No attempt was made to calculate the impact of the material used for packing, storing, and shipping the samples (such as coolers, bubble wrap, ice packs etc.) since SiteWise does not include materials such as these in its calculations. Furthermore, samples would be packed and shipped by the same methods for either low-flow or passive diffusion bag sampling so inclusion of these materials in the comparison of the two scenarios would not show any comparative difference.
- All investigation derived waste (IDW) generated from decontamination of equipment and well purging is disposed of at an on-site water treatment system which consists of an air stripper that sends treated water to infiltration galleries. Since the on-site treatment system operates continuously, using it to treat a small amount of IDW would not create any impact to the environment in terms of air stripper operation. However, the effect to the environment of the higher water use with low-flow sampling, including decontamination of the pumps, is included in the footprint comparison.

SAMPLE COLLECTION[1]	Event 1	Event 2	Event 3
Short Description of Event	Quarterly Sampling Only	Quarterly + Semi-Annual Sampling	Quarterly + Semi-Annual + Annual
Vehicle type (car, truck, suv, hybrid)	Light Truck	Light Truck	Light Truck
Fuel (gasoline, diesel)	Gasoline	Gasoline	Gasoline
Number of wells sampled	44	83 wells + 45 water levels	144 wells + 45 water levels
Distance traveled per day (miles)	10	10	10
Number of days sampling[2]	4	8	13
Number of travelers	2	2	2

[1] Wells are sampled on one of three schedules: quarterly, semi-annual, or annual. In order to input the sampling events into SiteWise™ V2, it is assumed that the sampling teams will mobilize four times per year with two of the mobilizations devoted solely to quarterly sampling (Event 1), one devoted to quarterly + semi-annual sampling (Event 2), and one devoted to quarterly + semi-annual + annual sampling (Event 3).
[2] The number of days sampling for each event is based on the number of wells sampled and the rate at which wells are sampled. A USGS study (Huffman, R. M., 2002) concluded that for a two person team, 12 wells could be sampled per day via PDB's. Water levels readings are assumed to be taken all in one day.
[3] An Interstate Technology Regulatory Council (ITRC 2002) brochure states that PDB's may be hung in a well for as long as one year between sampling events. Based on this finding, it is assumed that the team would hang a new PDB in each well following the recovery of a sample. No trips have to be made solely to hang a new PDB prior to collecting a sample.

SAMPLE SHIPMENT[1]	Event 1	Event 2	Event 3
Short Description of Event	Quarterly Sampling Only	Quarterly + Semi-Annual Sampling	Quarterly + Semi-Annual + Annual
Vehicle type (car, truck, suv, hybrid)	SUV	SUV	SUV
Fuel (gasoline, diesel)	Gasoline	Gasoline	Gasoline
Distance traveled per trip (miles)[2]	40	40	40
Number of trips	2	2	3
Number of travelers	1	1	1

[1] Samples are delivered from JBLM to Test America Labs in Seattle via an express courier, travelling in an SUV.
[2] Test America labs are located 20 miles away from JBLM. Since an express courier would most likely be making a dedicated trip with the samples, the round-trip mileage is used for each sample shipment. A report from Fort Lewis (USACE and Tetratech GEO) states that samples will be shipped via overnight courier once every week, so the number of trips to deliver samples is calculated based off of this information.

OPERATOR LABOR	Occupation 1
Choose occupation from drop-down menu	Operating engineers
Input total time worked onsite (hours)	400

The time worked is calculated based on an assumed 8 hour work day, with 25 total days worked for each laborer.

Well Sampling Case Study Low Flow Sampling

SAMPLE COLLECTION	Event 1	Event 2	Event 3
Short Description of Event	Quarterly Sampling Only	Quarterly + Semi-Annual Sampling	Quarterly + Semi-Annual + Annual
Vehicle type (car, truck, suv, hybrid)	Light Truck	Light Truck	Light Truck
Fuel (gasoline, diesel)	Gasoline	Gasoline	Gasoline
Number of wells sampled	44	83 wells + 45 water levels	144 wells + 45 water levels
Distance traveled per day (miles)	10	10	10
Number of days sampling[2]	9	18	30
Number of travelers	2	2	2

Wells are sampled on one of three schedules: quarterly, semi-annual, or annual. In order to input the sampling events into SiteWise™ V2, it is assumed that the sampling teams will mobilize four times per year with two of the mobilizations devoted solely to quarterly sampling (Event 1), one devoted to quarterly + semi-annual sampling (Event 2), and one devoted to quarterly + semi-annual + annual sampling (Event 3).

[2] The number of days sampling for each event is based on the number of wells sampled and the rate at which wells are sampled. A USGS study (Huffman, R. M., 2002) concluded that for a two person team, 5 wells could be sampled per day using low flow sampling. Water levels readings are assumed to be taken all in one day.

SAMPLE SHIPMENT	Event 1	Event 2	Event 3
Short Description of Event	Quarterly Sampling Only	Quarterly + Semi-Annual Sampling	Quarterly + Semi-Annual + Annual
Vehicle type (car, truck, suv, hybrid)	SUV	SUV	SUV
Fuel (gasoline, diesel)	Gasoline	Gasoline	Gasoline
Distance traveled per trip (miles)[1]	40	40	40
Number of trips	2	4	6
Number of travelers	1	1	1

[1]Samples are delivered from JBLM to Test America Labs in Seattle via an express courier, travelling in an SUV.

[2]Test America labs are located 20 miles away from JBLM. Since an express courier would most likely be making a dedicated trip with the samples, the round-trip mileage is used for each sample shipment. A report from Fort Lewis (USACE and Tetratech GEO 2011) states that samples will be shipped via overnight courier once every week, so the number of trips to deliver samples is calculated based off of this information.

Well Sampling Case Study Low Flow Sampling

PUMP OPERATION	Event 1	Event 2	Event 3
Short Description of Event	Quarterly Sampling Only	Quarterly + Semi-Annual Sampling	Quarterly + Semi-Annual + Annual
Pump type (discharge, extraction, etc.)	Low Flow Sampling Pump	Low Flow Sampling Pump	Low Flow Sampling Pump
Method 3 - NAME PLATE SPECIFICATIONS ARE KNOWN			
Pump horsepower (hp)[1]	0.5	0.5	0.5
Number of pumps operating	1	1	1
Operating time for each pump (hrs)[2]	22	41.5	72
Pump load[3]	1.0	1.0	1.0
Pump motor efficiency	0.85	0.85	0.85
[1]For the purposes of modeling low flow sampling in the low flow sampling scenario, it was assumed that a Grundfos Redi-Flo 2 electrical powered pump would be used [2]Operating time is based on the assumption that 30 minutes of pumping would be required in order for monitoring parameters of the purge water to stabilize at each well. Total time is calculated as (30 min/well) X (number of wells per sampling event). The volume of water purged is calculated by assuming a purge rate of 200 ml/min or 6000 ml or 1.6 gallons total per well. Further, it was assumed that the pump was decontaminated after use at each well with a 5 gal wash, followed by a 5 gal rinse, or 10 gallons of water per well for decontamination. Although in some circumstances, reuse of the decontamination solution may be permissible, it was assumed here that fresh solutions were used for each well [3] Pump load is entered as 1.0 since entering a value less than one is only done when system downtime is included in the calculations.			

OPERATOR LABOR	Occupation 1
Choose occupation from drop-down menu	Operating engineers
Input total time worked onsite (hours)	912
The time worked is calculated based on an assumed 8 hour work day, with 57 total days worked for each laborer.	

Well Sampling Case Study Comparison of Low Flow Sampling and Passive Diffusion Bags

Summary of Results

The assumptions detailed in the tables above were entered into SiteWise™, and the footprint calculations were then generated. The results from the calculations are presented in two methods.

- Method One: This method presents the results calculated for an entire year of sampling using either PDBs or low-flow sampling. The inputs and assumptions for this method are exactly the same as the ones in the tables preceding this page.
- Method Two: For this method, the impact of sampling a single well by either PDBs or low-flow sampling was calculated. To do this, the impact of performing one day of sampling using either method was calculated. Those results were then divided by the number of wells sampled in one day for each method (12 wells via PDBs and 5 via low-flow sampling). This method allows use of the case study results to determine qualitatively the impact difference between the two sampling methods for any number of wells. As noted below, since the assumptions are different for each site, application of the results from this case study should only be used qualitatively if applied to other sites.

General Discussion of Results

The results show that in general, PDB sampling has more GSR benefits than low flow sampling. This can be attributed to the fact that PDB sampling can complete more wells per day, meaning fewer days of field mobilization. Also, no equipment is needed for PDB sampling whereas low-flow sampling requires submersible pumps that must be powered and decontaminated after each well.

Note that these results do not represent an endorsement of one sampling method versus the other. GSR considerations are one of many factors in selecting a sampling method. Also, the limitations of using the results of this case study for other sites should be considered. Since assumptions will be different for each site, the results from this case study should only be used qualitatively when considering applying the results to other sites.

Tables summarizing the data generated by SiteWise™ V2, as well as selected charts generated in SiteWise™ V2, are displayed below:

Well Sampling Case Study Comparison of Low Flow Sampling and Passive Diffusion Bags

Table 1 Footprint of Both Sampling Methods

GSR Parameter	Low Flow Sampling	PDB Sampling
Environmental		
Energy (MMBtu)	7.356810484	3.35953835
Global warming potential (Metric tons CO2e)	0.560912676	0.266416238
Criteria air pollutant emissions (Metric tons NOx+SOx+PM10)	0.000313755	0.000116394
Water Use (gallons)	3132	0
Non-hazardous waste generation (tons)	0	0
Hazardous waste generation (tons)	0	0
Economic		
Up-front Cost		
Societal		
Injury or fatality risk	0.022054443	0.009717158
Predicted number of hours lost to injury	0.175944123	0.077517393

Table 2 Footprint of Sampling One Well with Both Sampling Methods

GSR Parameter	Low Flow Sampling *1 Well*	PDB Sampling *1 Well*
Environmental		
Energy (MMBtu)	6.25E-02	2.51E-02
Global warming potential (Metric tons CO2e)	4.88E-03	1.99E-03
Criteria air pollutant emissions (Metric tons NOx+SOx+PM10)	2.22E-06	8.09E-07
Water Use (gallons)	11.6	0.00E+00
Non-hazardous waste generation (tons)	0.00E+00	0.00E+00
Hazardous waste generation (tons)	0.00E+00	0.00E+00
Economic		
Up-front Cost		
Societal		
Injury or fatality risk	8.14E-05	3.39E-05
Predicted number of hours lost to injury	6.49E-04	2.70E-04

Well Sampling Case Study Comparison of Low Flow Sampling and Passive Diffusion Bags

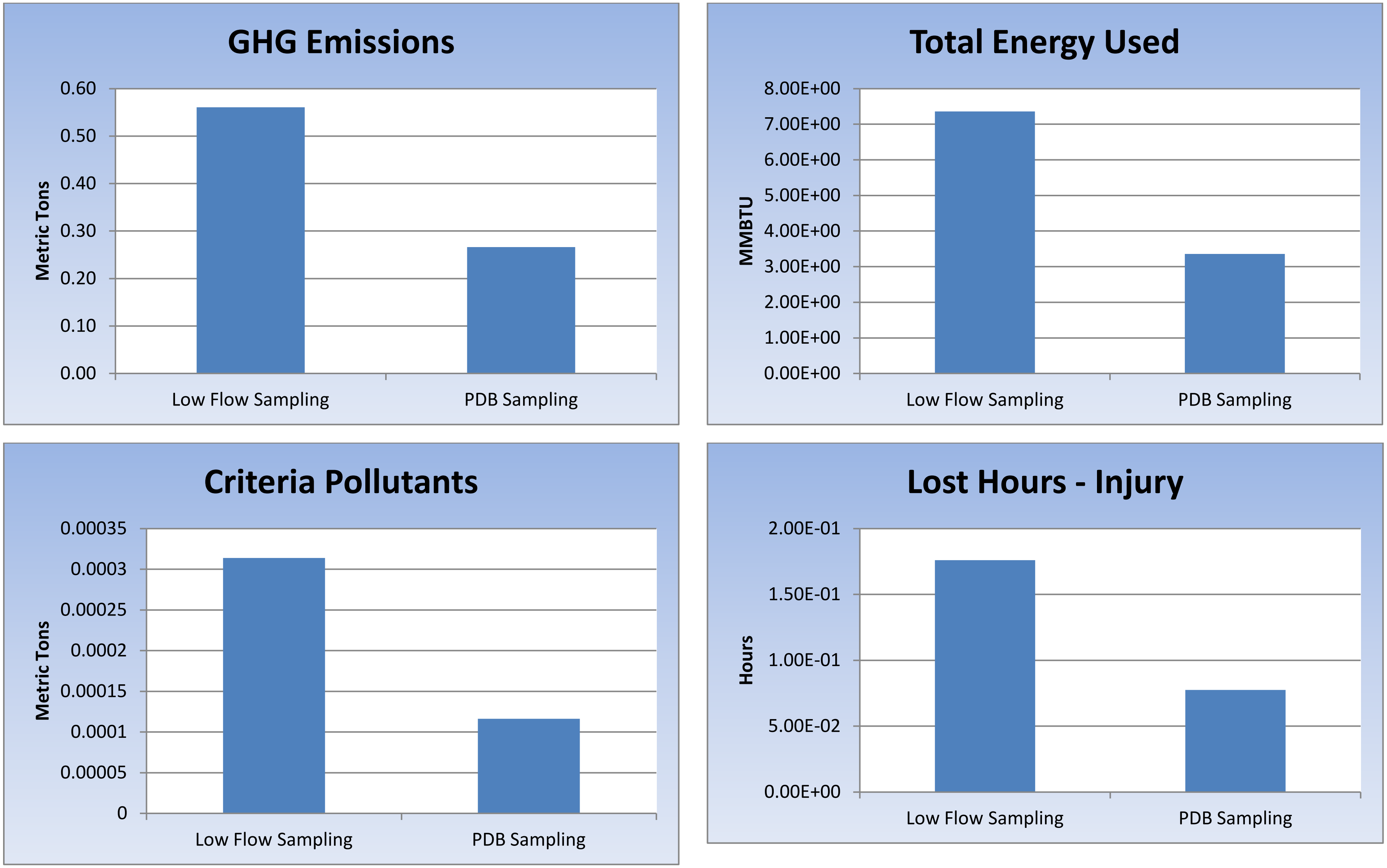


Figure 1 Graphic Display of Footprint Data from Table 1

Well Sampling Case Study Comparison of Low Flow Sampling and Passive Diffusion Bags

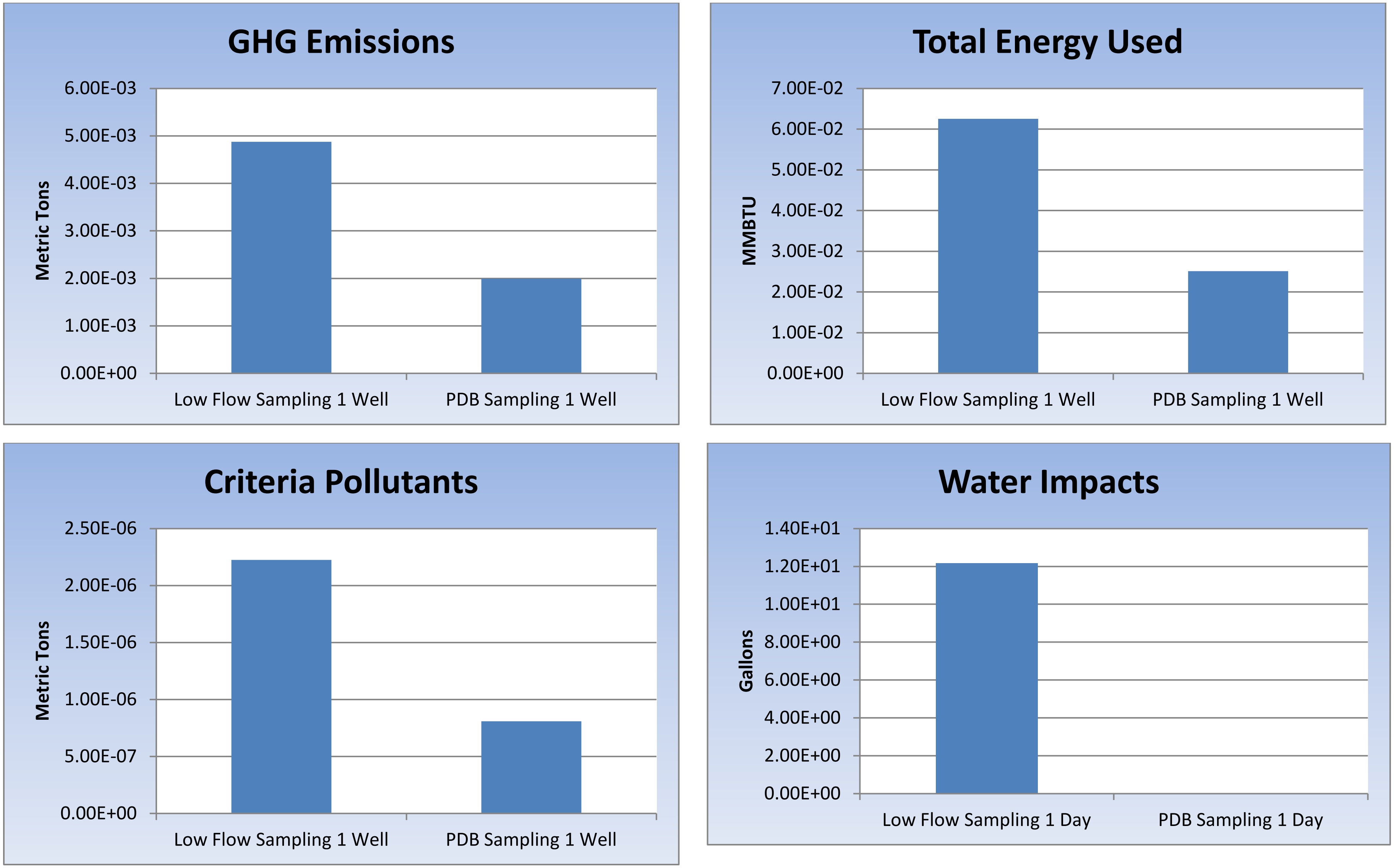


Figure 2 Graphic Display of Footprint Data from Table 2

References:

US Army Corps of Engineers Environmental and Munitions Center of Expertise and Tetratech GEO (USACE and Tetratech GEO 2011), Remedial System Evaluation, Joint Base Lewis-McChord, Washington (Former Fort Lewis Portion), Final Report, prepared by the US Army Corps of Engineers Environmental and Munitions Center of Expertise and Tetratech GEO, May 2011.

Geosyntec Consultants. (Geosyntec 2006,). *Standard Operating Procedures for Groundwater Sampling, January 2006.* Retrieved July 17, 2011, from http://ndep.nv.gov/bmi/docs/appendix_c07.pdfHuffman, R. L. (Huffman, 2002). *Comparison of Passive Diffusion Bag Samplersand Submersible Pump Sampling Methods forMonitoring Volatile Organic Compounds in GroundWater at Area 6, Naval Air StationWhidbey Island, Washington.* Retrieved July 13, 2011, from USGS Webpage: http://pubs.usgs.gov/wri/wri024203/pdf/wri024203.pdf

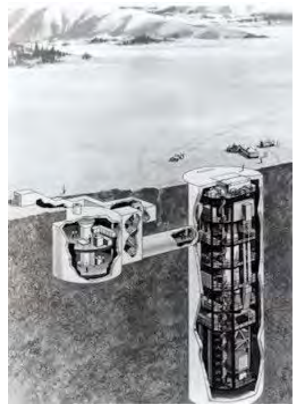
Interstate Technology Regulatory Council. (ITRC, 2002). *Passive Diffusion Bag (PDB) Samplers FAQ's, February 2002.* Retrieved July 13, 2011, from ITRC Web: http://www.itrcweb.org/Documents/Diffusion_Passive_Samplers/PDBFAQs2.pdf

Puls, R. J., & Barcelona, M. J. (Puls and Barcelona, 1996). *LOW-FLOW (MINIMAL DRAWDOWN) GROUND-WATER SAMPLING PROCEDURES, April 1996.* Retrieved July 13, 2011, from Environmental Protection Agency Website: http://www.epa.gov/tio/tsp/download/lwflw2a.pdf

FINAL GREEN AND SUSTAINABLE REMEDIATION (GSR) ANALYSIS REPORT

FORMER SCHILLING ATLAS MISSILE SITE S-5 MCPHERSON COUNTY, KANSAS

FUDS PROJECT NO. B07KS026301



Prepared by U.S. Army Corps of Engineers Environmental and Munitions Center of Expertise (EM CX)
for the
U.S. Army Corps of Engineers
Kansas City District
Kansas City, Missouri

September 2010

1 INTRODUCTION

The purpose of this green and sustainable remediation (GSR) analysis is to quantify GSR metrics so this information can be considered along with the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) decision-making criteria, in the selection of a preferred remedy for the Proposed Plan for remediation of contaminated groundwater at the Former Schilling Atlas Missile Site S-5 (Schilling S-5) in McPherson County, Kansas. Inclusion of GSR considerations in the decision process supports the recently issued Department of Defense GSR policy (10 August 2009), "Consideration of Green and Sustainable Remediation Practices in the Defense Environmental Restoration Program," which directs DoD components to consider and implement GSR practices "when and where they make sense" (US Department of Defense, 2009). The DoD policy also requests DoD agencies to document, through a series of briefings, sites where GSR has been considered and incorporated. Additionally, consideration and incorporation of sustainable practices will support the goals of the Army, as expressed in the FY 2010-2011 Army Environmental Cleanup Strategic Plan (US Army, 2009), which encourages "project managers to seek opportunities to incorporate options for minimizing the impact on the environment of cleanup actions undertaken at Army installations."

The GSR analysis was prepared by the U.S. Army Corps of Engineers, Huntsville Center Environmental and Munitions Center of Expertise (EM-CX) in cooperation with the U.S Army Corps of Engineers Kansas City District (KCD) and was based on information from the Feasibility Study (FS) prepared by the KCD (USACE, 2009), modeling prepared by KCD predicting remediation times using the numerical model REMCHLOR (USACE, 2010), and additional information provided by KCD, as necessary for the analysis. KCD also prepared and provided cost tables for comparison of the alternatives on both GSR considerations and cost.

2 BACKGROUND

The general location of the S-5 Site is approximately 7 miles north of the City of McPherson, Kansas in McPherson County. The primary contaminants in groundwater at the Site are TCE and *cis*-1,2-DCE, which occur in the dissolved phase and are migrating with the groundwater flow (USACE, 2009). The FS evaluated five alternatives for remediation of the groundwater, which are listed below:

- Alternative 1g: No Action,
- Alternative 2g: Long-Term Monitoring (LTM),
- Alternative 3g: Enhanced Anaerobic Bioremediation (EAB) with Monitored Natural Attenuation (MNA),
- Alternative 4g: Permeable Reactive Barrier (PRB) or Biowall with MNA, and
- Alternative 5g: In-Situ Chemical Oxidation (ISCO) with MNA

The EM-CX evaluated and compared Alternatives 2g, 3g, and 5g for GSR metrics, as these are the alternatives indicated by KCD that are being considered for selection of the preferred alternative in the Proposed Plan. In addition, a screening of In-situ Thermal Desorption, a technology not included in the FS, was included in the sustainability analysis as requested by the KCD.

During the sustainability analysis, it was noted that, although the alternatives as developed and compared in the FS designated LTM in Alternative 2g and MNA in Alternatives 3g and 5g, LTM was found to be adequate for Alternative 5g after active remediation, and for Alternative 3g after completion and monitoring of active remediation. Therefore, Alternatives 2g, 3g, and 5g were recast as the following:

- Alternative 2g: Long-Term Monitoring/Monitoring Natural Attenuation (LTM/MNA),
- Alternative 3g: Enhanced Anaerobic Bioremediation (EAB) with Monitored Natural Attenuation (MNA)/Long-Term Monitoring (LTM), and
- Alternative 5g: ISCO with LTM

These alternatives were then used to evaluate and compare the alternatives with respect to GSR metrics and cost.

3 SUSTAINABILITY EVALUATION

A sustainability evaluation was performed on the Schilling S-5 remedies being considered for selection as the preferred remedy for the groundwater, which, as discussed above, included 1) a stand-alone LTM, also termed a stand-alone MNA alternative, 2) an in-situ EAB remedy, initially with MNA monitoring during and immediately following active treatment (4 years) and LTM after 4 years, and an ISCO remedy followed by LTM after active treatment (active treatment lasting 2 years). In-situ Thermal Treatment was also screened by looking at one of the sustainability metrics, energy use (200-300 kW-hr/cu yd times the same remediation volume as Alternatives 3g and 5g). The screening indicated an energy use of 8.7E+04 MMBTU, which was two orders of magnitude greater than any of the other alternatives. With the agreement of the KCD, the technology was not evaluated further.

The SiteWise™ Green and Sustainable Remediation (GSR) Tool jointly developed by Battelle, Inc., the Navy, the USACE, and the Army, was used to perform the GSR analysis (Battelle, 2010). This tool calculates eight GSR metrics: greenhouse gas (GHG) emissions, energy use, water use, oxides of nitrogen (NOx) emissions, sulfur oxides (SOx) emissions, particulate emissions of 10 micrometers or less diameter (PM_{10}), accident risk, and fatality risk. The assumptions used to determine the input parameters for two scenarios (30 years and alternative close-out times as predicted by REMCHLOR modeling) are included in Tables A1-1 through A1-6 in Attachment 1.

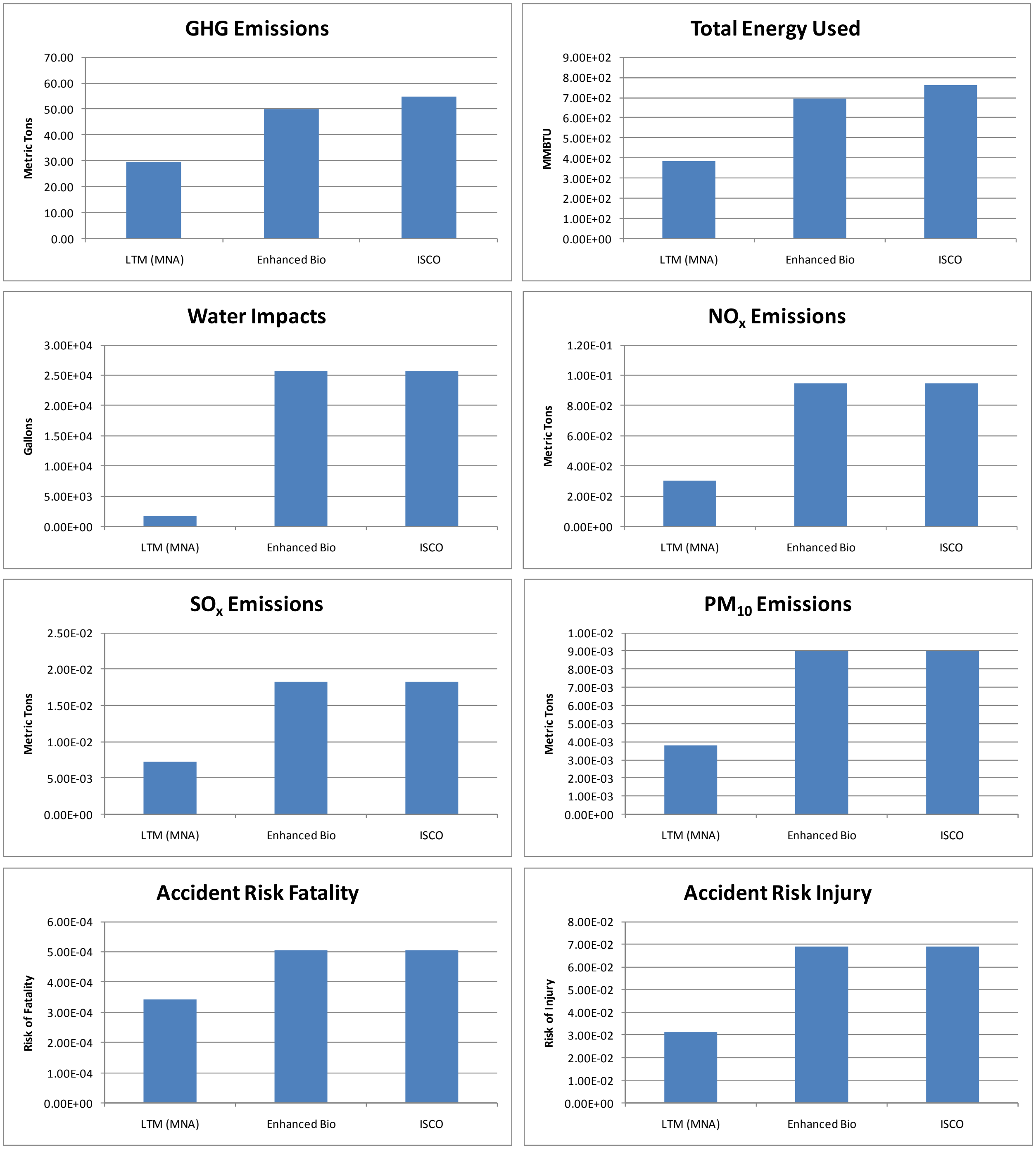
The 30 year time period was modeled because this is the time period typically used to evaluate and compare alternatives in the Feasibility Study stage (US Environmental Protection Agency, 1988). The second scenario, which used the times predicted by the REMCHLOR modeling for each alternative to reach close-out, was modeled as being more representative of the realistic remediation time frames. The times obtained from the REMCHLOR modeling used in the analysis were 208 years for the stand-alone LTM (MNA) remedy and 78 years for both the EAB/MNA/LTM and ISCO/LTM alternatives (USACE, 2010).

The results comparing the alternatives using the 30 year time frame are in Table 1. Figure 1 also shows each of the sustainability metrics graphically. Detailed results are presented in Attachment 2. The results indicate that the stand-alone LTM (MNA) alternative has approximately 45-70% of the GHG emissions, energy use, and accident and fatality risks of the EAB/MNA/LTM and ISCO/LTM alternatives, and approximately 30-40% of the NOx, SOx, and PM_{10} emissions. LTM water consumption amounts to less than 10% of the in-situ remedies.

Table 1. Sustainability results for the Schilling S-5 alternatives based on a 30 year remediation time frame

Remedial Alternatives	GHG Emissions	Total energy Used	Water Consumption	NO_x emissions	SO_x Emissions	PM_{10} Emissions	Accident Risk Fatality	Accident Risk Injury
	metric ton	MMBTU	gallons	metric ton	metric ton	metric ton		
LTM (MNA)	29.72	3.85E+02	1.75E+03	3.06E-02	7.24E-03	3.80E-03	3.42E-04	3.11E-02
EAB/MNA/LTM	50.02	6.96E+02	2.58E+04	9.44E-02	1.83E-02	9.02E-03	5.04E-04	6.89E-02
ISCO/LTM	54.75	7.60E+02	2.58E+04	9.44E-02	1.83E-02	9.02E-03	5.04E-04	6.89E-02

Figure 1. Comparison of the SiteWise™ sustainability metrics across the different alternatives for a 30 year time period

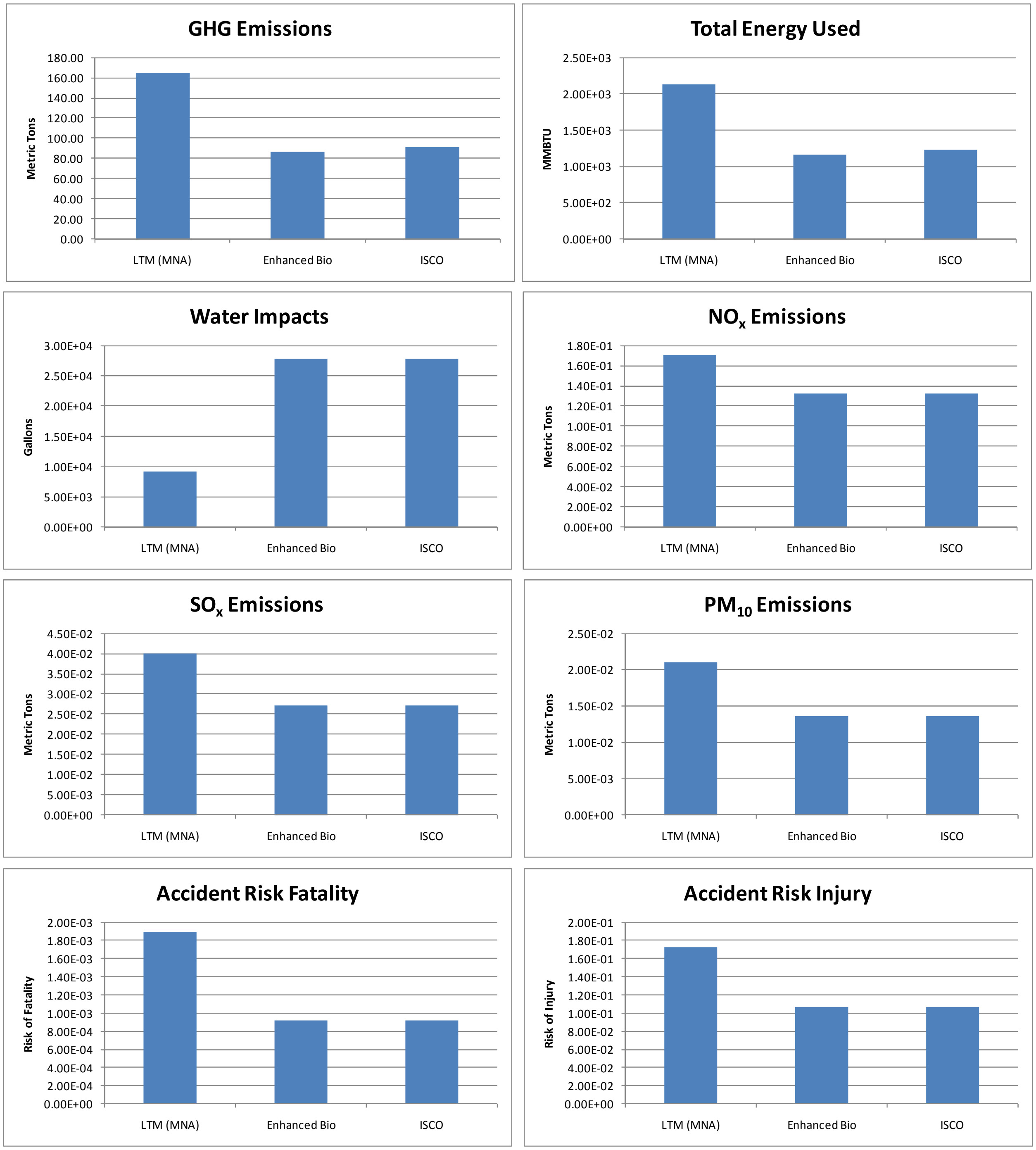


The results of the second scenario using the estimated close-out times for each alternative (78 years for the in-situ alternatives and 208 years for the stand-alone LTM (MNA) alternative) are shown in Table 2 and Figure 2. Detailed results are presented in Attachment 2. The results are significantly different than the results using the 30 year time period. GHG emissions, energy use, and accident and fatality risks of the stand-alone LTM (MNA) alternative are now approximately 60-100% higher than those of the in-situ/LTM alternatives, with NOx, SOx and PM_{10} emissions approximately 30-55% higher. The water use for the stand-alone LTM alternative is nearly 70% lower than the in-situ remedies, largely reflecting the significant amount of water necessary in the in-situ remedies for dilution and injection of substrate.

Table 2. Sustainability results for the Schilling S-5 alternatives based on remediation time frames predicted by REMCHLOR modeling (208 years, LTM; 78 years, EAB/MNA/LTM and ISCO/LTM)

Remedial Alternatives	GHG Emissions	Total energy Used	Water Consumption	NO_x emissions	SO_x Emissions	PM_{10} Emissions	Accident Risk Fatality	Accident Risk Injury
	metric ton	MMBTU	gallons	metric ton	metric ton	metric ton		
LTM (MNA)	164.96	2.14E+03	9.12E+03	1.70E-01	4.01E-02	2.11E-02	1.89E-03	1.72E-01
EAB/MNA/LTM	86.49	1.17E+03	2.77E+04	1.32E-01	2.71E-02	1.37E-02	9.23E-04	1.07E-01
ISCO/LTM	91.22	1.23E+03	2.77E+04	1.32E-01	2.71E-02	1.37E-02	9.23E-04	1.07E-01

Figure 2. Comparison of the SiteWise^{TM} sustainability metrics across the different alternatives for time periods predicted by REMCHLOR (208 years, LTM/MNA; 78 years, EAB/MNA/LTM and ISCO/LTM)



4 COST EVALUATION

In order to be compliant with DoD policy on determining "when and where" it makes sense to incorporate GSR practices, cost was included as part of this sustainability analysis. Using the same assumptions that were used for the sustainability evaluation, KCD calculated costs for the three alternatives being considered for the Proposed Plan using a 30-year timeframe as well as times to remediation closeout as estimated by REMCHLOR (Julius Calderon, pers. comm., 2010). Detailed cost tables are in Attachment 3; the costs for the two time frames are summarized in Table 3.

Table 3. Cost summary

Remedial Alternatives	Total Estimated Summed Cost ($)	Total Estimated Summed Cost ($)	Total Present Worth Estimated Cost ($)[1]	Total Present Worth Estimated Cost ($)[1]
	30 yr remediation time frame	REMCHLOR time frame (208 yr – LTM (MNA), 78 yr – in-situ remedies)	30 yr remediation time frame	REMCHLOR time frame (208 yr – LTM (MNA), 78 yr – in-situ remedies)
LTM (MNA)	1.04M	5.88M	0.78M	1.24M
EAB/MNA/LTM	7.27M	8.63M	6.77M	7.11M
ISCO/LTM	7.60M	8.96M	7.11M	7.45M

[1] 2.7% Discount Rate assumed

As Table 3 indicates, the total summed cost assuming the 30 year timeframe for the LTM (MNA) alternative is significantly less (~85% lower) than the costs for the in-situ alternatives. However, the total summed cost using the remediation close-out times predicted by REMCHLOR for the LTM (MNA) alternative is significantly closer (~70%) to the in-situ remedies. This narrowing of cost difference is due to the lower monitoring time (78 years) with the in-situ alternatives compared to the monitoring time of the LTM (MNA) alternative (208 years). The present worth total estimated costs for the LTM (MNA) alternative for both the 30 year and extended remediation closeout timeframes are significantly less (more than 80% lower) than those of the in-situ remedies.

5 SUMMARY OF RESULTS

Calculations of GSR metrics and cost were performed for the alternatives being considered for recommendation in the Proposed Plan for remediation of contaminated groundwater at the Schilling S-5 site. For the 30 year timeframe typically considered for feasibility studies, the calculations indicate that the GSR metrics are significantly less for the stand-alone LTM alternative as compared to the in-situ alternatives. However, when the same alternatives are evaluated for the predicted remediation times (78 years for the in-situ alternatives and 208 years for the LTM alternative), the GSR metrics are generally greater for the LTM alternative compared to the in-situ alternatives. The exception is water use, where the water use for the LTM alternative is predicted to be ~10% of the in-situ alternatives.

For the summed total costs, the 30 year timeframe indicated significantly lower costs for the stand-alone LTM alternative. More comparable summed total costs between the alternatives for the predicted times to remediation closeout were found, with the LTM stand-alone alternative predicted to have ~70% of the summed total cost of the in-situ alternatives. The present worth total costs, assuming a yearly discount rate of 2.9%, were found to be significantly less with the stand-alone LTM alternative for both timeframes compared to the in-situ alternatives, largely because of the loading of the relatively high costs associated with the in-situ alternatives at the beginning of the cost analysis cycle. It is noted that the Army environmental remediation funding process may be more consistent with the summed total costs, as environmental remediation projects in Army databases are tracked with "Cost-to-Complete" or summed total costs, rather than present worth costs.

6 RECOMMENDATIONS

It is recommended that the GSR analysis as outlined above be included and the results considered in the process of selecting the preferred alternative for the Proposed Plan. It is also recommended that this process of consideration/incorporation be documented in the Proposed Plan and decision document. This information can then be used to document to DoD that GSR has been considered and incorporated "when and where" it makes sense on this project.

It is also recommended that once the final alternative has been selected that another GSR analysis be performed to "green" the remedy. Two examples of areas where GSR gains could be obtained are in the method of sampling (for example, use of passive sampling bags instead of collection of samples with pumps) and the frequency of sampling (for example, after some time period, sampling on a less frequent basis than annually). These potential areas, as well as other areas, would be identified and evaluated to determine if, when, and where they would make sense.

7 REFERENCES

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US Army Corps of Engineers 2010. Memorandum for Record, Former Schilling Atlas Missile Site S-5, McPherson County, Kansas, FUDS Project No. B07KS026301, prepared by Kansas City District, February 2010.

US Army Corps of Engineers 2009. Final Feasibility Study for Remedial Action, Former Schilling Atlas Missile Site S-5, McPherson County, Kansas, FUDS Project No. B07KS026301, prepared by Kansas City District, April 2009.

US Department of Defense 2009. Memorandum "Consideration of Green and Sustainable Remediation Practices in the Defense Environmental Restoration Program," 10 August 2009, https://www.denix.osd.mil/portal/page/portal/content/environment/cleanup/WN/Green%20and%20Sustainable%20Remidiation%20Policy.pdf.

US Environmental Protection Agency 1988. Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA, Interim Final, EPA/540/G-89/004, October 1988, http://www.epa.gov/superfund/policy/remedy/sfremedy/rifs/overview.htm.

Attachment 1

Assumptions for SiteWise^{TM} Analysis

Table A1-1

Alternative 2g - Monitored Natural Attenuation					
Duration 30 years					
Longterm Monitoring Module					
Personnel Transportation - Road					
Mob/demob	39 sampling events	78 trips	200 mi one-way	2 travelers	Gasoline-fueled SUV (19 mpg)
Sampling - years 1-2 - hotel to site	8 sampling events; 8 wells qrtly, 13 wells ann; 4 wells/day	44 trips	10 mi one-way	2 travelers	Gasoline-fueled SUV (19 mpg)
Sampling - years 3-5 - hotel to site	6 sampling events; 8 wells semiann; 4 wells/day	24 trips	10 mi one-way	2 travelers	Gasoline-fueled SUV (19 mpg)
Sampling - years 6-30 - hotel to site	25 sampling events; 8 wells ann; 4 wells/day	100 trips	10 mi one-way	2 travelers	Gasoline-fueled SUV (19 mpg)
Equipment Transporatation - Road					
Truck to site to pick up IDW	39 sampling events	39 trips	200 mi one-way	Load: 0 tons	Diesel-fueled truck with emissions reduction
Residual Handling					
Truck from site to dispose IDW	39 sampling events	39 trips	200 mi one-way	Load: 0.15 tons	Diesel-fueled truck with emissions reduction; 5 gal/well; differs from RACER; doesn't count added weight for 13 wells during years 1-2
Pump Operation					
Low-flow sampling	39 sampling events	672 hrs	0.5 hp pump	0.4 pump load; 0.85 pump efficiency	4 wells/day

Miscellaneous comments and assumptions:

Unless indicated otherwise all input parameters are based on assumptions in RACER (2009 FS)

No change in transportation technology (fuel source or fuel efficiency) over duration of project

No change in sampling technology over duration of project

Well replacement not required

Five-year review site inspections performed coincidental with groundwater monitoring events; no additional vehicles or personnel required

Table A1-2

Alternative 3g - Enhanced Bio					
Duration 30 years					
Longterm Monitoring Module					
Personnel Transportation - Road					
Mob/demob	39 sampling events	78 trips	200 mi one-way	2 travelers	Gasoline-fueled SUV (19 mpg)
Sampling - years 1-2 - hotel to site	8 sampling events; 8 wells qrtly, 13 wells ann; 4 wells/day	44 trips	10 mi one-way	2 travelers	Gasoline-fueled SUV (19 mpg)
Sampling - years 3-5 - hotel to site	6 sampling events; 8 wells semiann; 4 wells/day	24 trips	10 mi one-way	2 travelers	Gasoline-fueled SUV (19 mpg)
Sampling - years 6-30 - hotel to site	25 sampling events; 8 wells ann; 4 wells/day	100 trips	10 mi one-way	2 travelers	Gasoline-fueled SUV (19 mpg)
Equipment Transporatation - Road					
Truck to site to pick up IDW	39 sampling events	39 trips	200 mi one-way	Load: 0 tons	Diesel-fueled truck with emissions reduction
Residual Handling					
Truck from site to dispose IDW	39 sampling events	39 trips	200 mi one-way	Load: 0.15 tons	Diesel-fueled truck with emissions reduction; 5 gal/well; differs from RACER; doesn't count added weight for 13 wells during years 1-2
Pump Operation					
Low-flow sampling	39 sampling events	672 hrs	0.5 hp pump	0.4 pump load; 0.85 pump efficiency	4 wells/day

Table A1-2 (cont.)

Remedial Action Operations Module					
Treatment Chemicals & Materials					
Amendment injections	4 injection events	2,568 lbs	550 injection pts		Vegetable oil (mixed 5% oil-95% water)
Personnel Transporatation - Road					
Mob/demob	4 injection events	8 trips	200 mi one-way	2 travelers	Gasoline-fueled SUV (19 mpg)
Rig demob	4 injection events	4 trips	200 mi one-way	2 travelers	Diesel-fueled light truck
Truck to site to pick up IDW	4 injection events; 28 days/event	224 trips	10 mi one-way	2 travelers	Gasoline-fueled SUV (19 mpg)
Equipment Transporatation - Road					
Rig & substrate trailer mob	4 injection events	4 trips	200 mi one-way	Load: 1.5 tons	Diesel-fueled truck with emissions reduction
Water truck for substrate	4 injection events	4 trips	10 mi one-way	Load: 25 tons	Diesel-fueled truck with emissions reduction
Water truck for substrate	4 injection events	4 trips	10 mi one-way	Load: 0 tons	Diesel-fueled truck with emissions reduction
Truck to site to pick up drummed IDW	4 injection events	4 trips	200 mi one-way	Load: 0 tons	Diesel-fueled truck with emissions reduction
Truck to site to pick up bulk IDW	4 injection events	4 trips	200 mi one-way	Load: 0 tons	Diesel-fueled truck with emissions reduction
Truck to site to pick up bulk IDW	4 injection events	4 trips	200 mi one-way	Load: 0 tons	Diesel-fueled truck with emissions reduction
Drilling					
Direct push borings	4 injection events	550 injection points	0.5 hr/location	60 ft borings	Diesel-fueled rig
Residual Handling					
Truck from site to dispose drummed IDW	4 injection events	4 trips	200 mi one-way	Load: 16 tons	Diesel-fueled heavy duty truck with emissions reduction
Truck from site to dispose bulk IDW	4 injection events	4 trips	200 mi one-way	Load: 26 tons	Diesel-fueled heavy duty truck with emissions reduction
Truck from site to dispose bulk IDW	4 injection events	4 trips	200 mi one-way	Load: 26 tons	Diesel-fueled heavy duty truck with emissions reduction

Miscellaneous comments and assumptions:

Unless indicated otherwise all input parameters are based on assumptions in RACER (2009 FS)

No change in transportation technology (fuel source or fuel efficiency) over duration of project

No change in sampling technology over duration of project

Well replacement not required

Five-year review site inspections performed coincidental with groundwater monitoring events; no additional vehicles or personnel required

Table A1-3

Alternative 5g - ISCO					
Duration 30 years					
Longterm Monitoring Module					
Personnel Transportation - Road					
Mob/demob	39 sampling events	78 trips	200 mi one-way	2 travelers	Gasoline-fueled SUV (19 mpg)
Sampling - years 1-2 - hotel to site	8 sampling events; 8 wells qrtly, 13 wells ann; 4 wells/day	44 trips	10 mi one-way	2 travelers	Gasoline-fueled SUV (19 mpg)
Sampling - years 3-5 - hotel to site	6 sampling events; 8 wells semiann; 4 wells/day	24 trips	10 mi one-way	2 travelers	Gasoline-fueled SUV (19 mpg)
Sampling - years 6-30 - hotel to site	25 sampling events; 8 wells ann; 4 wells/day	100 trips	10 mi one-way	2 travelers	Gasoline-fueled SUV (19 mpg)
Equipment Transporatation - Road					
Truck to site to pick up IDW	39 sampling events	39 trips	200 mi one-way	Load: 0 tons	Diesel-fueled truck with emissions reduction
Residual Handling					
Truck from site to dispose IDW	39 sampling events	39 trips	200 mi one-way	Load: 0.15 tons	Diesel-fueled truck with emissions reduction; 5 gal/well; differs from RACER; doesn't count added weight for 13 wells during years 1-2
Pump Operation					
Low-flow sampling	39 sampling events	672 hrs	0.5 hp pump	0.4 pump load; 0.85 pump efficiency	4 wells/day

Table A1-3 (cont.)

Remedial Action Operations Module					
Treatment Chemicals & Materials					
Amendment injections	4 injection events	2,568 lbs	550 injection pts		Hydrogen peroxide (mixed 5% oil-95% water)
Personnel Transporatation - Road					
Mob/demob	4 injection events	8 trips	200 mi one-way	2 travelers	Gasoline-fueled SUV (19 mpg)
Rig demob	4 injection events	4 trips	200 mi one-way	2 travelers	Diesel-fueled light truck
Truck to site to pick up IDW	4 injection events; 28 days/event	224 trips	10 mi one-way	2 travelers	Gasoline-fueled SUV (19 mpg)
Equipment Transporatation - Road					
Rig & substrate trailer mob	4 injection events	4 trips	200 mi one-way	Load: 1.5 tons	Diesel-fueled truck with emissions reduction
Water truck for substrate	4 injection events	4 trips	10 mi one-way	Load: 25 tons	Diesel-fueled truck with emissions reduction
Water truck for substrate	4 injection events	4 trips	10 mi one-way	Load: 0 tons	Diesel-fueled truck with emissions reduction
Truck to site to pick up drummed IDW	4 injection events	4 trips	200 mi one-way	Load: 0 tons	Diesel-fueled truck with emissions reduction
Truck to site to pick up bulk IDW	4 injection events	4 trips	200 mi one-way	Load: 0 tons	Diesel-fueled truck with emissions reduction
Truck to site to pick up bulk IDW	4 injection events	4 trips	200 mi one-way	Load: 0 tons	Diesel-fueled truck with emissions reduction
Drilling					
Direct push borings	4 injection events	550 injection points	0.5 hr/location	60 ft borings	Diesel-fueled rig
Residual Handling					
Truck from site to dispose drummed IDW	4 injection events	4 trips	200 mi one-way	Load: 16 tons	Diesel-fueled heavy duty truck with emissions reduction
Truck from site to dispose bulk IDW	4 injection events	4 trips	200 mi one-way	Load: 26 tons	Diesel-fueled heavy duty truck with emissions reduction
Truck from site to dispose bulk IDW	4 injection events	4 trips	200 mi one-way	Load: 26 tons	Diesel-fueled heavy duty truck with emissions reduction

Miscellaneous comments and assumptions:

Unless indicated otherwise all input parameters are based on assumptions in RACER (2009 FS)

No change in transportation technology (fuel source or fuel efficiency) over duration of project

No change in sampling technology over duration of project

Well replacement not required

Five-year review site inspections performed coincidental with groundwater monitoring events; no additional vehicles or personnel required

Table A1-4

Alternative 2g - Monitored Natural Attenuation					
Duration 208 years					
Longterm Monitoring Module					
Personnel Transportation - Road					
Mob/demob	217 sampling events	434 trips	200 mi one-way	2 travelers	Gasoline-fueled SUV (19 mpg)
Sampling - years 1-2 - hotel to site	8 sampling events; 8 wells qrtly, 13 wells ann; 4 wells/day	44 trips	10 mi one-way	2 travelers	Gasoline-fueled SUV (19 mpg)
Sampling - years 3-5 - hotel to site	6 sampling events; 8 wells semiann; 4 wells/day	24 trips	10 mi one-way	2 travelers	Gasoline-fueled SUV (19 mpg)
Sampling - years 6-30 - hotel to site	25 sampling events; 8 wells ann; 4 wells/day	100 trips	10 mi one-way	2 travelers	Gasoline-fueled SUV (19 mpg)
Sampling - years 31-208 - hotel to site	178 sampling events; 8 wells ann; 4 wells/day	712 trips	10 mi one-way	2 travelers	Gasoline-fueled SUV (19 mpg)
Equipment Transporatation - Road					
Truck to site to pick up IDW	217 sampling events	217 trips	200 mi one-way	Load: 0 tons	Diesel-fueled truck with emissions reduction
Residual Handling					
Truck from site to dispose IDW	217 sampling events	217 trips	200 mi one-way	Load: 0.15 tons	Diesel-fueled truck with emissions reduction; 5 gal/well; differs from RACER; doesn't count added weight for 13 wells during years 1-2
Pump Operation					
Low-flow sampling	217 sampling events	3,520 hrs	0.5 hp pump	0.4 pump load; 0.85 pump efficiency	4 wells/day

Miscellaneous comments and assumptions:

Unless indicated otherwise all input parameters are based on assumptions in RACER (2009 FS)

No change in transportation technology (fuel source or fuel efficiency) over duration of project

No change in sampling technology over duration of project

Well replacement not required

Five-year review site inspections performed coincidental with groundwater monitoring events; no additional vehicles or personnel required

Table A1-5

Alternative 3g - Enhanced Bio					
Duration 78 years					
Longterm Monitoring Module					
Personnel Transportation - Road					
Mob/demob	87 sampling events	174 trips	200 mi one-way	2 travelers	Gasoline-fueled SUV (19 mpg)
Sampling - years 1-2 - hotel to site	8 sampling events; 8 wells qrtly, 13 wells ann; 4 wells/day	44 trips	10 mi one-way	2 travelers	Gasoline-fueled SUV (19 mpg)
Sampling - years 3-5 - hotel to site	6 sampling events; 8 wells semiann; 4 wells/day	24 trips	10 mi one-way	2 travelers	Gasoline-fueled SUV (19 mpg)
Sampling - years 6-30 - hotel to site	25 sampling events; 8 wells ann; 4 wells/day	100 trips	10 mi one-way	2 travelers	Gasoline-fueled SUV (19 mpg)
Sampling - years 31-78 - hotel to site	48 sampling events; 8 wells ann; 4 wells/day	192 trips	10 mi one-way	2 travelers	Gasoline-fueled SUV (19 mpg)
Equipment Transporatation - Road					
Truck to site to pick up IDW	87 sampling events	87 trips	200 mi one-way	Load: 0 tons	Diesel-fueled truck with emissions reduction
Residual Handling					
Truck from site to dispose IDW	87 sampling events	87 trips	200 mi one-way	Load: 0.15 tons	Diesel-fueled truck with emissions reduction; 5 gal/well; differs from RACER; doesn't count added weight for 13 wells during years 1-2
Pump Operation					
Low-flow sampling	87 sampling events	1,440 hrs	0.5 hp pump	0.4 pump load; 0.85 pump efficiency	4 wells/day

Table A1-5 (cont.)

Remedial Action Operations Module					
Treatment Chemicals & Materials					
Amendment injections	4 injection events	2,568 lbs	550 injection pts		Vegetable oil (mixed 5% oil-95% water)
Personnel Transporatation - Road					
Mob/demob	4 injection events	8 trips	200 mi one-way	2 travelers	Gasoline-fueled SUV (19 mpg)
Rig demob	4 injection events	4 trips	200 mi one-way	2 travelers	Diesel-fueled light truck
Truck to site to pick up IDW	4 injection events; 28 days/event	224 trips	10 mi one-way	2 travelers	Gasoline-fueled SUV (19 mpg)
Equipment Transporatation - Road					
Rig & substrate trailer mob	4 injection events	4 trips	200 mi one-way	Load: 1.5 tons	Diesel-fueled truck with emissions reduction
Water truck for substrate	4 injection events	4 trips	10 mi one-way	Load: 25 tons	Diesel-fueled truck with emissions reduction
Water truck for substrate	4 injection events	4 trips	10 mi one-way	Load: 0 tons	Diesel-fueled truck with emissions reduction
Truck to site to pick up drummed IDW	4 injection events	4 trips	200 mi one-way	Load: 0 tons	Diesel-fueled truck with emissions reduction
Truck to site to pick up bulk IDW	4 injection events	4 trips	200 mi one-way	Load: 0 tons	Diesel-fueled truck with emissions reduction
Truck to site to pick up bulk IDW	4 injection events	4 trips	200 mi one-way	Load: 0 tons	Diesel-fueled truck with emissions reduction
Drilling					
Direct push borings	4 injection events	550 injection points	0.5 hr/location	60 ft borings	Diesel-fueled rig
Residual Handling					
Truck from site to dispose drummed IDW	4 injection events	4 trips	200 mi one-way	Load: 16 tons	Diesel-fueled heavy duty truck with emissions reduction
Truck from site to dispose bulk IDW	4 injection events	4 trips	200 mi one-way	Load: 26 tons	Diesel-fueled heavy duty truck with emissions reduction
Truck from site to dispose bulk IDW	4 injection events	4 trips	200 mi one-way	Load: 26 tons	Diesel-fueled heavy duty truck with emissions reduction

Miscellaneous comments and assumptions:

Unless indicated otherwise all input parameters are based on assumptions in RACER (2009 FS)

No change in transportation technology (fuel source or fuel efficiency) over duration of project

No change in sampling technology over duration of project

Well replacement not required

Five-year review site inspections performed coincidental with groundwater monitoring events; no additional vehicles or personnel required

Table A1-6

Alternative 5g - ISCO					
Duration 78 years					
Longterm Monitoring Module					
Personnel Transportation - Road					
Mob/demob	87 sampling events	174 trips	200 mi one-way	2 travelers	Gasoline-fueled SUV (19 mpg)
Sampling - years 1-2 - hotel to site	8 sampling events; 8 wells qrtly, 13 wells ann; 4 wells/day	44 trips	10 mi one-way	2 travelers	Gasoline-fueled SUV (19 mpg)
Sampling - years 3-5 - hotel to site	6 sampling events; 8 wells semiann; 4 wells/day	24 trips	10 mi one-way	2 travelers	Gasoline-fueled SUV (19 mpg)
Sampling - years 6-30 - hotel to site	25 sampling events; 8 wells ann; 4 wells/day	100 trips	10 mi one-way	2 travelers	Gasoline-fueled SUV (19 mpg)
Sampling - years 31-78 - hotel to site	48 sampling events; 8 wells ann; 4 wells/day	192 trips	10 mi one-way	2 travelers	Gasoline-fueled SUV (19 mpg)
Equipment Transporatation - Road					
Truck to site to pick up IDW	87 sampling events	87 trips	200 mi one-way	Load: 0 tons	Diesel-fueled truck with emissions reduction
Residual Handling					
Truck from site to dispose IDW	87 sampling events	87 trips	200 mi one-way	Load: 0.15 tons	Diesel-fueled truck with emissions reduction; 5 gal/well; differs from RACER; doesn't count added weight for 13 wells during years 1-2
Pump Operation					
Low-flow sampling	87 sampling events	1,440 hrs	0.5 hp pump	0.4 pump load; 0.85 pump efficiency	4 wells/day

Table A1-6 (cont.)

Remedial Action Operations Module					
Treatment Chemicals & Materials					
Amendment injections	4 injection events	2,568 lbs	550 injection pts		Hydrogen peroxide (mixed 5% oil-95% water)
Personnel Transporatation - Road					
Mob/demob	4 injection events	8 trips	200 mi one-way	2 travelers	Gasoline-fueled SUV (19 mpg)
Rig demob	4 injection events	4 trips	200 mi one-way	2 travelers	Diesel-fueled light truck
Truck to site to pick up IDW	4 injection events; 28 days/event	224 trips	10 mi one-way	2 travelers	Gasoline-fueled SUV (19 mpg)
Equipment Transporatation - Road					
Rig & substrate trailer mob	4 injection events	4 trips	200 mi one-way	Load: 1.5 tons	Diesel-fueled truck with emissions reduction
Water truck for substrate	4 injection events	4 trips	10 mi one-way	Load: 25 tons	Diesel-fueled truck with emissions reduction
Water truck for substrate	4 injection events	4 trips	10 mi one-way	Load: 0 tons	Diesel-fueled truck with emissions reduction
Truck to site to pick up drummed IDW	4 injection events	4 trips	200 mi one-way	Load: 0 tons	Diesel-fueled truck with emissions reduction
Truck to site to pick up bulk IDW	4 injection events	4 trips	200 mi one-way	Load: 0 tons	Diesel-fueled truck with emissions reduction
Truck to site to pick up bulk IDW	4 injection events	4 trips	200 mi one-way	Load: 0 tons	Diesel-fueled truck with emissions reduction
Drilling					
Direct push borings	4 injection events	550 injection points	0.5 hr/location	60 ft borings	Diesel-fueled rig
Residual Handling					
Truck from site to dispose drummed IDW	4 injection events	4 trips	200 mi one-way	Load: 16 tons	Diesel-fueled heavy duty truck with emissions reduction
Truck from site to dispose bulk IDW	4 injection events	4 trips	200 mi one-way	Load: 26 tons	Diesel-fueled heavy duty truck with emissions reduction
Truck from site to dispose bulk IDW	4 injection events	4 trips	200 mi one-way	Load: 26 tons	Diesel-fueled heavy duty truck with emissions reduction

Miscellaneous comments and assumptions:

Unless indicated otherwise all input parameters are based on assumptions in RACER (2009 FS)

No change in transportation technology (fuel source or fuel efficiency) over duration of project

No change in sampling technology over duration of project

Well replacement not required

Five-year review site inspections performed coincidental with groundwater monitoring events; no additional vehicles or personnel required

Attachment 2

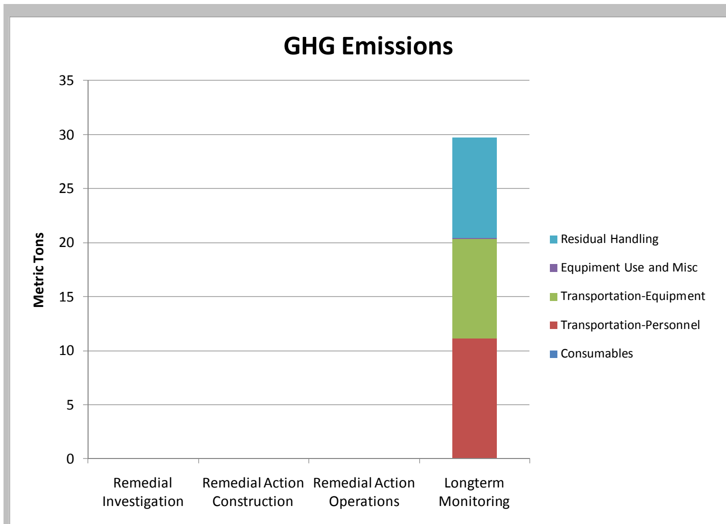
Detailed Results from SiteWise^{TM} Analysis

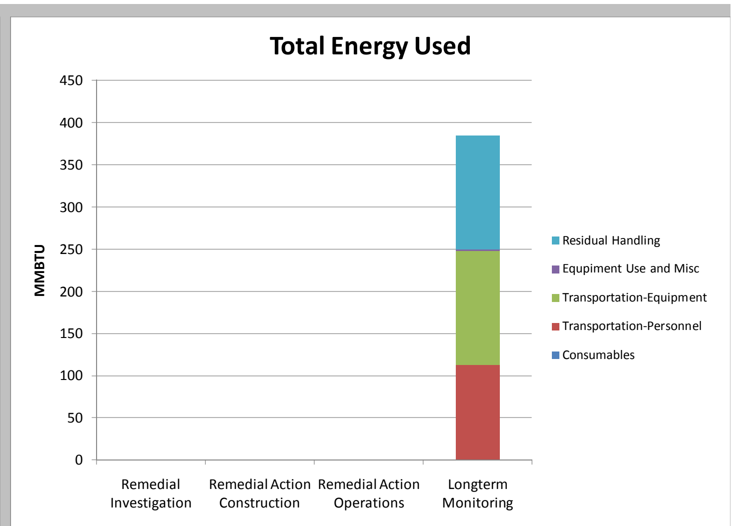
Long-Term Monitoring (MNA)

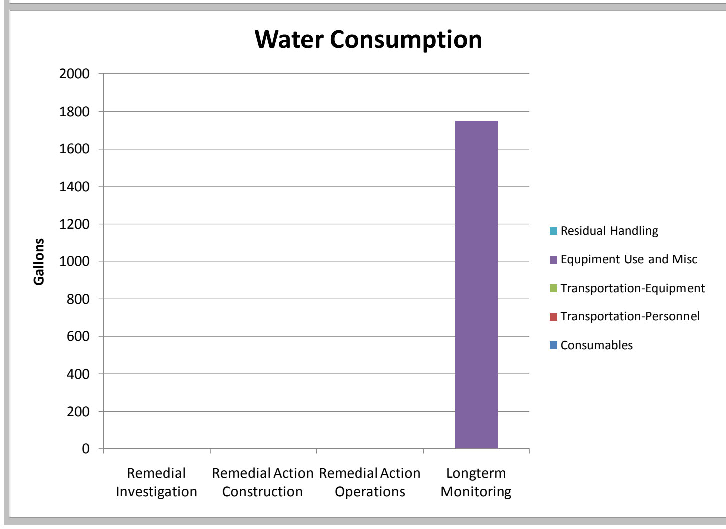
30-Year Scenario

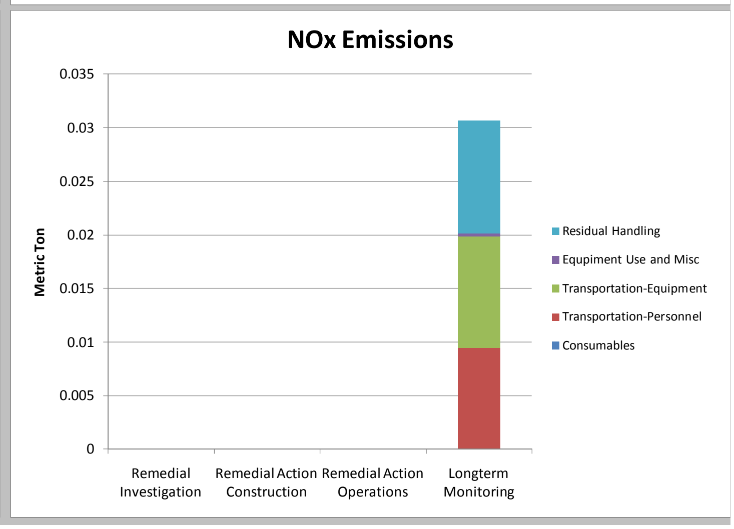
Sustainable Remediation - Environmental Footprint Summary
LTM (MNA)

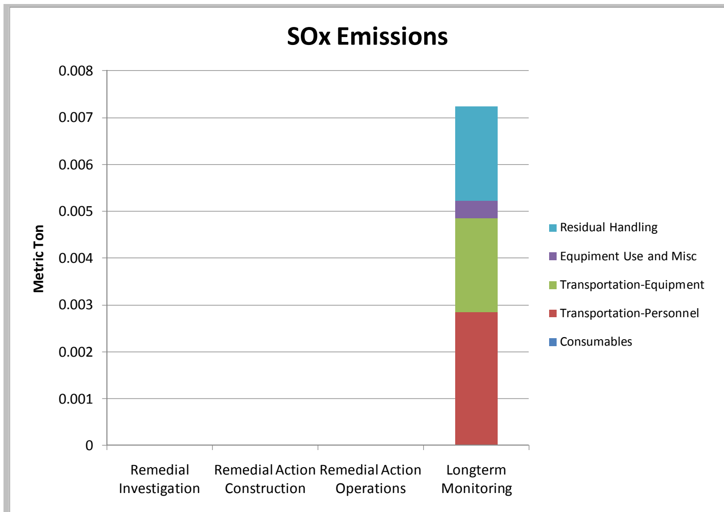
Phase	Activities	GHG Emissions metric ton	Total energy Used MMBTU	Water Consumption gallons	NOx emissions metric ton	SOx Emissions metric ton	PM10 Emissions metric ton	Accident Risk Fatality	Accident Risk Injury
Remedial Investigation	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Remedial Action Construction	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Remedial Action Operations	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Longterm Monitoring	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	11.11	1.1E+02	NA	9.4E-03	2.9E-03	1.8E-03	2.9E-04	2.1E-02
	Transportation-Equipment	9.24	1.4E+02	NA	1.1E-02	2.0E-03	9.8E-04	1.9E-05	3.9E-03
	Equipment Use and Misc	0.11	1.2E+00	1.8E+03	2.1E-04	3.6E-04	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	9.26	1.4E+02	NA	1.1E-02	2.0E-03	9.8E-04	2.9E-05	6.1E-03
	Sub-Total	29.72	3.85E+02	1.75E+03	3.06E-02	7.24E-03	3.80E-03	3.42E-04	3.11E-02
Total		**3.0E+01**	**3.8E+02**	**1.8E+03**	**3.1E-02**	**7.2E-03**	**3.8E-03**	**3.4E-04**	**3.1E-02**

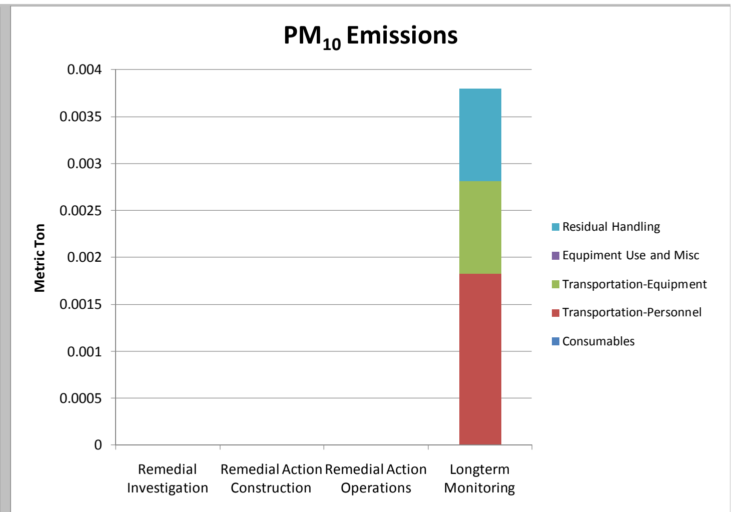

GHG Emissions
Metric Tons
0
5
10
15
20
25
30
35
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

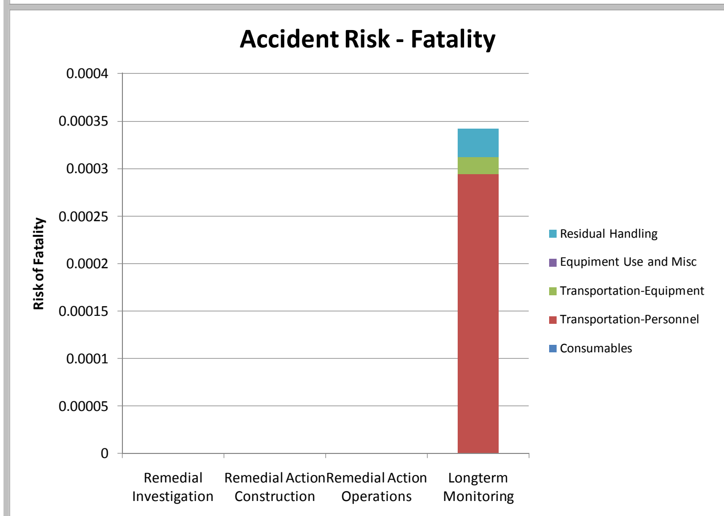

Total Energy Used
MMBTU
0
50
100
150
200
250
300
350
400
450
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

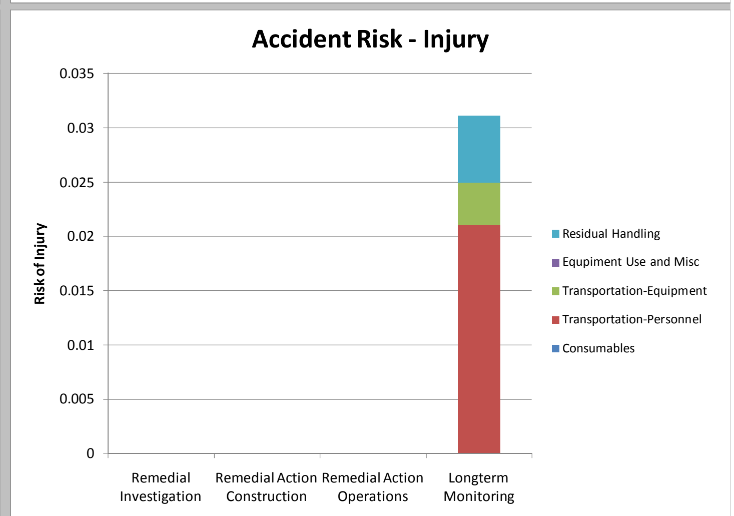

Water Consumption
Gallons
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


NOx Emissions
Metric Ton
0
0.005
0.01
0.015
0.02
0.025
0.03
0.035
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


SOx Emissions
Metric Ton
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


PM$_{10}$ Emissions
Metric Ton
0.004
0.0035
0.003
0.0025
0.002
0.0015
0.001
0.0005
0
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


Accident Risk - Fatality
Risk of Fatality
0.0004
0.00035
0.0003
0.00025
0.0002
0.00015
0.0001
0.00005
0
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

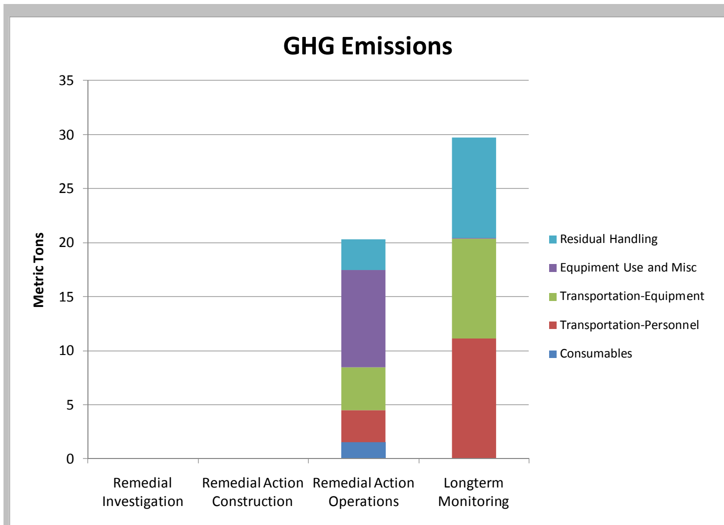

Accident Risk - Injury
Risk of Injury
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

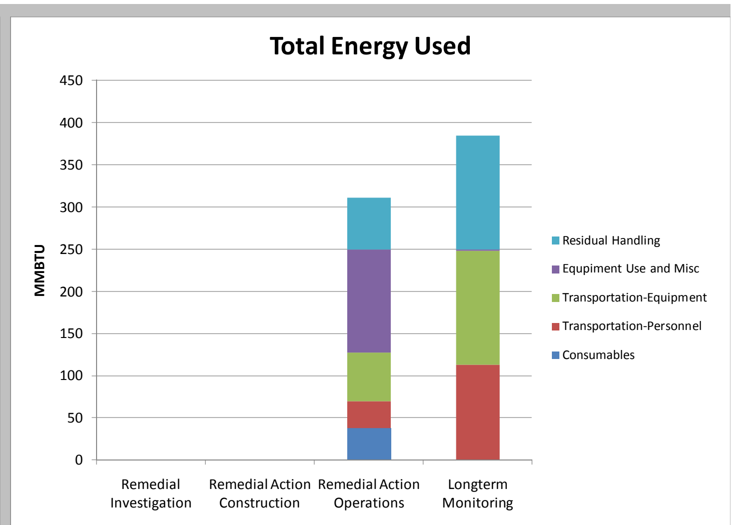
Enhanced Anaerobic Bioremediation

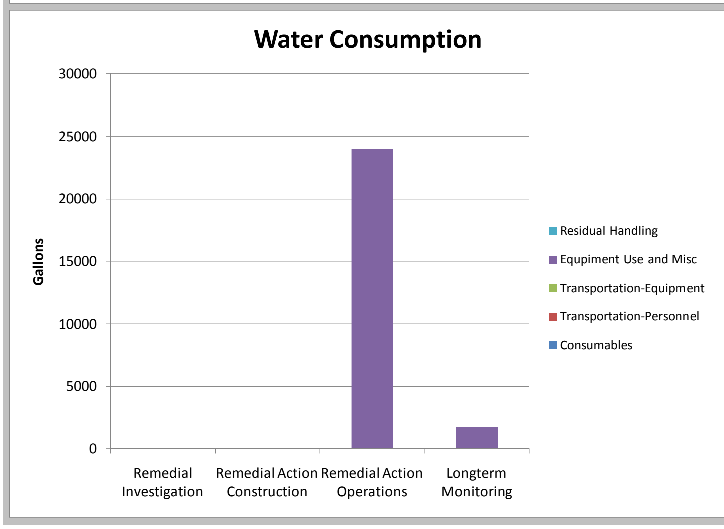
30-Year Scenario

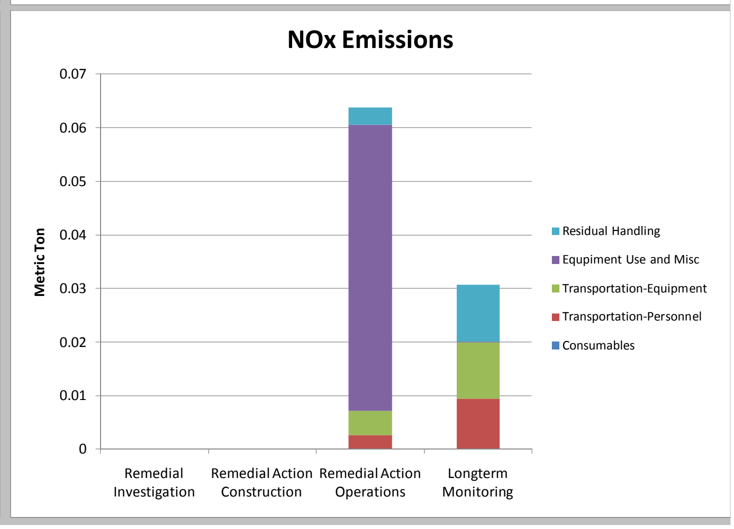
Sustainable Remediation - Environmental Footprint Summary
Enhanced Bio

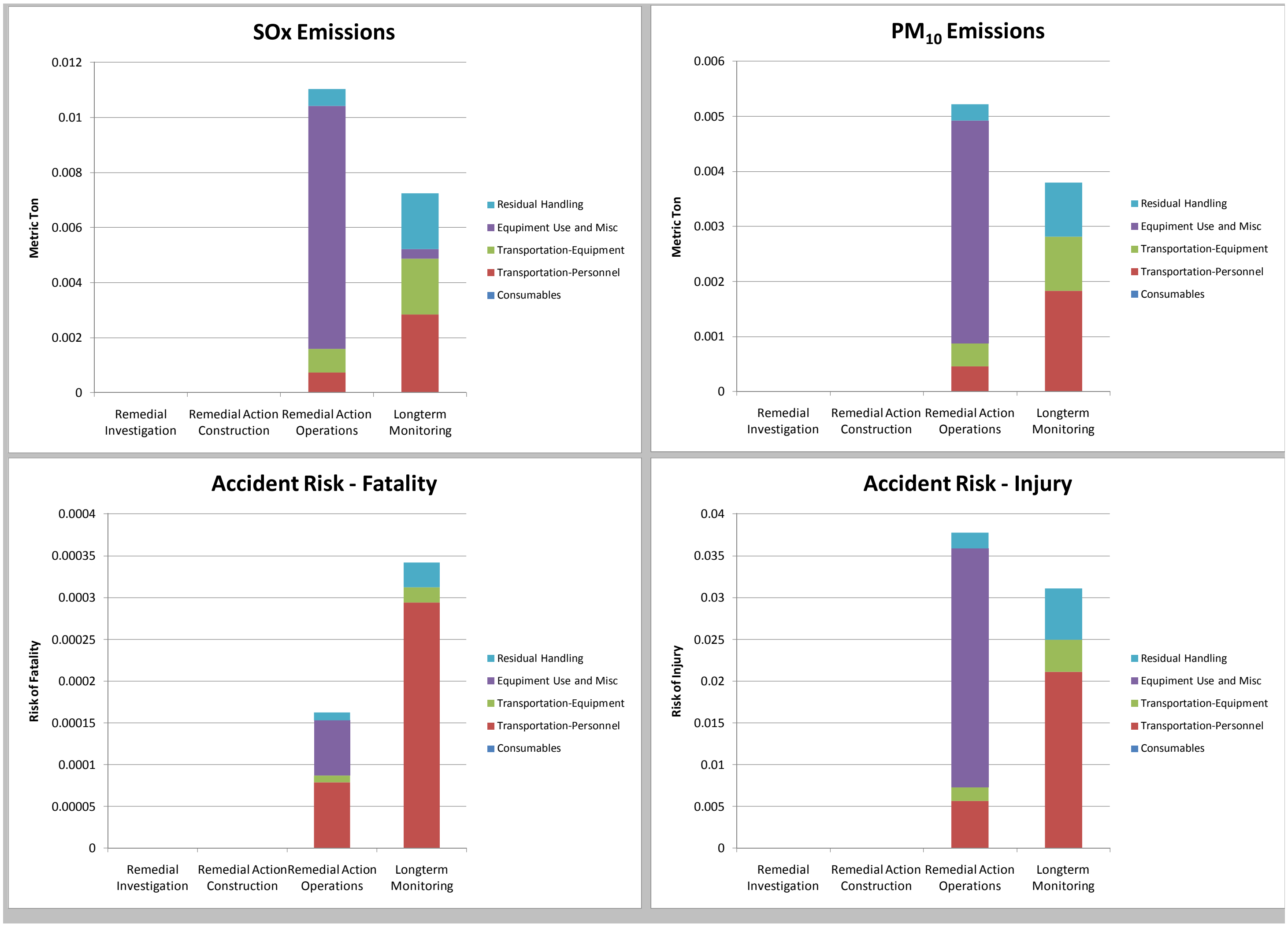
Phase	Activities	GHG Emissions	Total energy Used	Water Consumption	NOx emissions	SOx Emissions	PM10 Emissions	Accident Risk Fatality	Accident Risk Injury
		metric ton	MMBTU	gallons	metric ton	metric ton	metric ton		
Remedial Investigation	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Remedial Action Construction	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Remedial Action Operations	Consumables	1.54	3.8E+01	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	2.97	3.2E+01	NA	2.7E-03	7.4E-04	4.6E-04	7.9E-05	5.7E-03
	Transportation-Equipment	3.93	5.8E+01	NA	4.5E-03	8.6E-04	4.2E-04	7.9E-06	1.6E-03
	Equipment Use and Misc	9.01	1.2E+02	2.4E+04	5.3E-02	8.8E-03	4.0E-03	6.7E-05	2.9E-02
	Residual Handling	2.85	6.1E+01	NA	3.2E-03	6.2E-04	3.0E-04	9.1E-06	1.9E-03
	Sub-Total	20.31	3.11E+02	2.40E+04	6.38E-02	1.10E-02	5.22E-03	1.62E-04	3.78E-02
Longterm Monitoring	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	11.11	1.1E+02	NA	9.4E-03	2.9E-03	1.8E-03	2.9E-04	2.1E-02
	Transportation-Equipment	9.24	1.4E+02	NA	1.1E-02	2.0E-03	9.8E-04	1.9E-05	3.9E-03
	Equipment Use and Misc	0.11	1.2E+00	1.8E+03	2.1E-04	3.6E-04	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	9.26	1.4E+02	NA	1.1E-02	2.0E-03	9.8E-04	2.9E-05	6.1E-03
	Sub-Total	29.72	3.85E+02	1.75E+03	3.06E-02	7.24E-03	3.80E-03	3.42E-04	3.11E-02
Total		**5.0E+01**	**7.0E+02**	**2.6E+04**	**9.4E-02**	**1.8E-02**	**9.0E-03**	**5.0E-04**	**6.9E-02**


GHG Emissions
Metric Tons
35
30
25
20
15
10
5
0
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


Total Energy Used
MMBTU
450
400
350
300
250
200
150
100
50
0
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


Water Consumption
Gallons
30000
25000
20000
15000
10000
5000
0
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


NOx Emissions
Metric Ton
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables



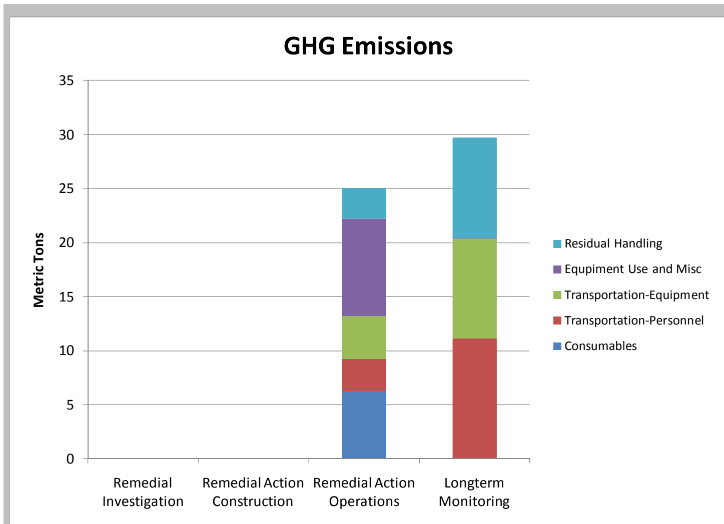
SOx Emissions
Metric Ton
0.012
0.01
0.008
0.006
0.004
0.002
0
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables
PM10 Emissions
Metric Ton
0.006
0.005
0.004
0.003
0.002
0.001
0
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables
Accident Risk - Fatality
Risk of Fatality
0.0004
0.00035
0.0003
0.00025
0.0002
0.00015
0.0001
0.00005
0
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables
Accident Risk - Injury
Risk of Injury
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

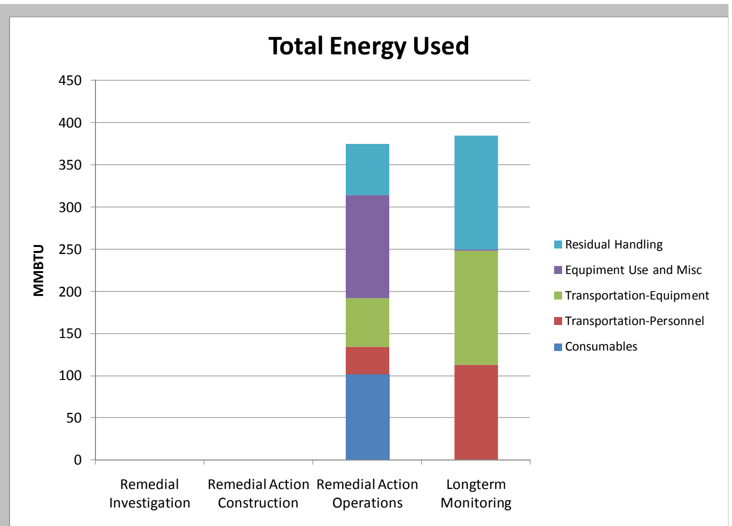
In-Situ Chemical Oxidation

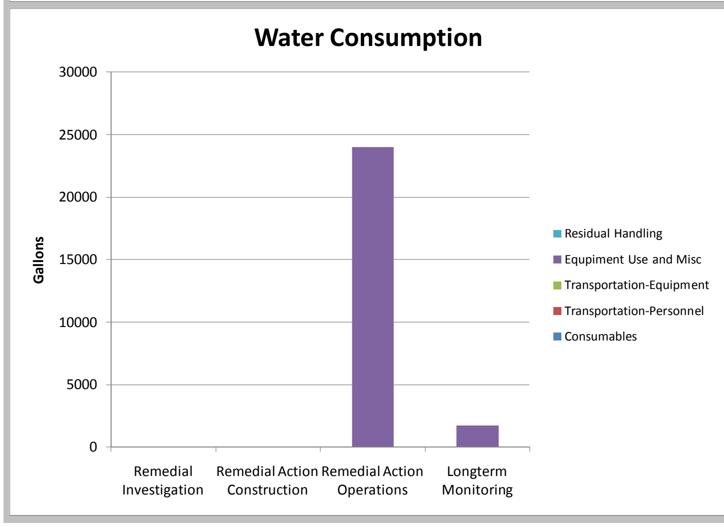
30-Year Scenario

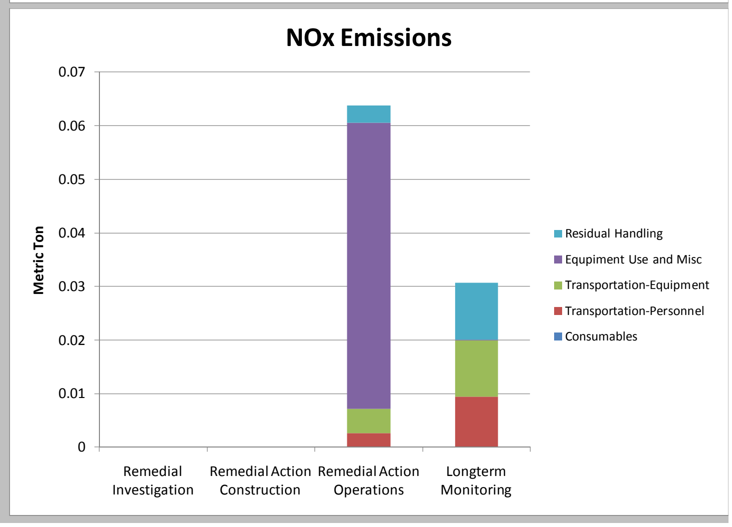
Sustainable Remediation - Environmental Footprint Summary
ISCO

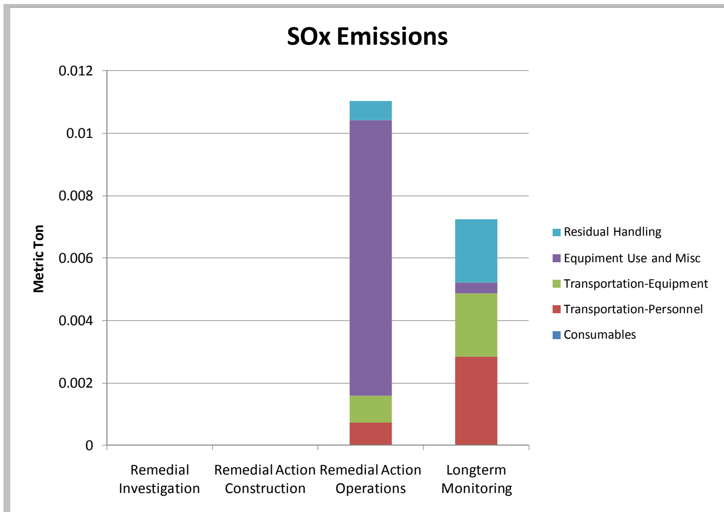
Phase	Activities	GHG Emissions (metric ton)	Total energy Used (MMBTU)	Water Consumption (gallons)	NOx emissions (metric ton)	SOx Emissions (metric ton)	PM10 Emissions (metric ton)	Accident Risk Fatality	Accident Risk Injury
Remedial Investigation	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Remedial Action Construction	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Remedial Action Operations	Consumables	6.27	1.0E+02	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	2.97	3.2E+01	NA	2.7E-03	7.4E-04	4.6E-04	7.9E-05	5.7E-03
	Transportation-Equipment	3.93	5.8E+01	NA	4.5E-03	8.6E-04	4.2E-04	7.9E-06	1.6E-03
	Equipment Use and Misc	9.01	1.2E+02	2.4E+04	5.3E-02	8.8E-03	4.0E-03	6.7E-05	2.9E-02
	Residual Handling	2.85	6.1E+01	NA	3.2E-03	6.2E-04	3.0E-04	9.1E-06	1.9E-03
	Sub-Total	25.04	3.75E+02	2.40E+04	6.38E-02	1.10E-02	5.22E-03	1.62E-04	3.78E-02
Longterm Monitoring	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	11.11	1.1E+02	NA	9.4E-03	2.9E-03	1.8E-03	2.9E-04	2.1E-02
	Transportation-Equipment	9.24	1.4E+02	NA	1.1E-02	2.0E-03	9.8E-04	1.9E-05	3.9E-03
	Equipment Use and Misc	0.11	1.2E+00	1.8E+03	2.1E-04	3.6E-04	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	9.26	1.4E+02	NA	1.1E-02	2.0E-03	9.8E-04	2.9E-05	6.1E-03
	Sub-Total	29.72	3.85E+02	1.75E+03	3.06E-02	7.24E-03	3.80E-03	3.42E-04	3.11E-02
Total		**5.5E+01**	**7.6E+02**	**2.6E+04**	**9.4E-02**	**1.8E-02**	**9.0E-03**	**5.0E-04**	**6.9E-02**


GHG Emissions
Metric Tons
35
30
25
20
15
10
5
0
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

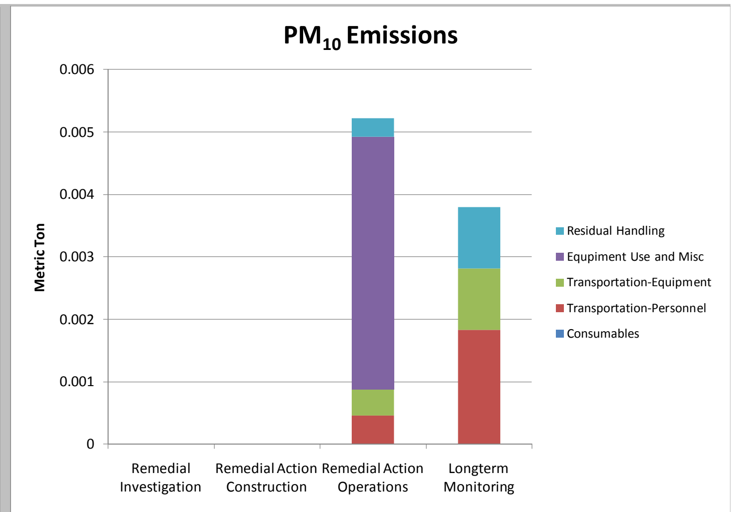

Total Energy Used
MMBTU
450
400
350
300
250
200
150
100
50
0
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


Water Consumption
Gallons
30000
25000
20000
15000
10000
5000
0
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

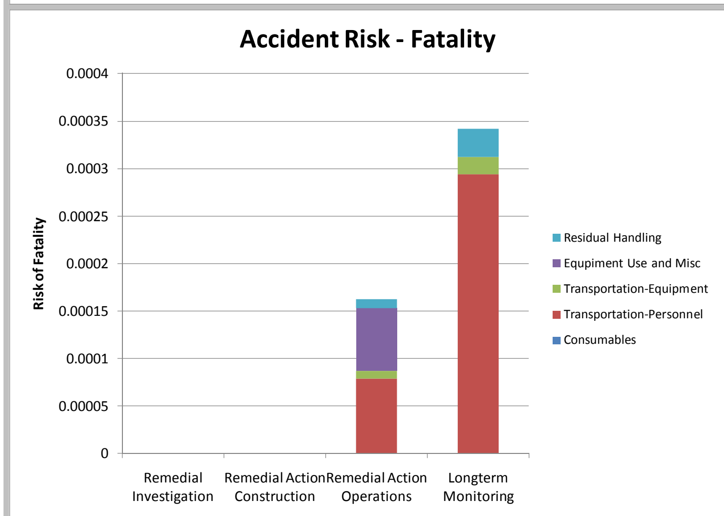

NOx Emissions
Metric Ton
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables



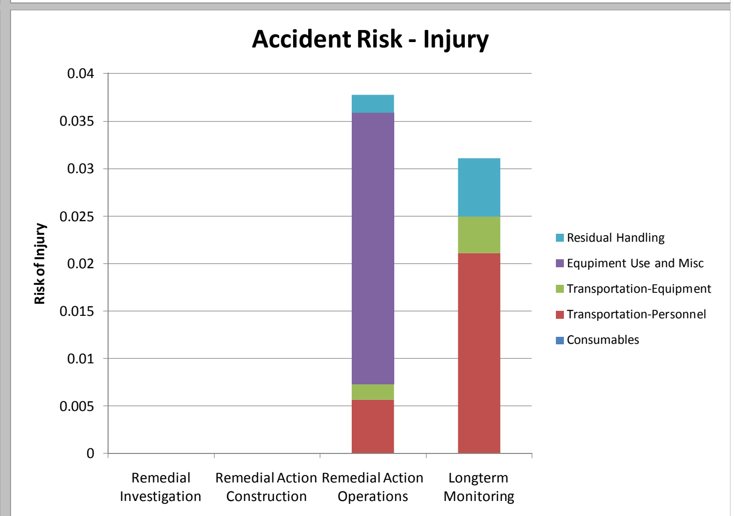
SOx Emissions
Metric Ton
0.012
0.01
0.008
0.006
0.004
0.002
0
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables



PM10 Emissions
Metric Ton
0.006
0.005
0.004
0.003
0.002
0.001
0
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables



Accident Risk - Fatality
Risk of Fatality
0.0004
0.00035
0.0003
0.00025
0.0002
0.00015
0.0001
0.00005
0
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables



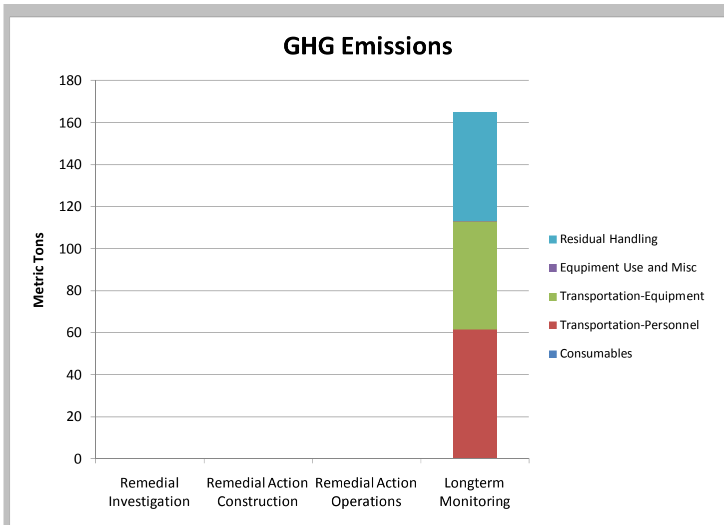
Accident Risk - Injury
Risk of Injury
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

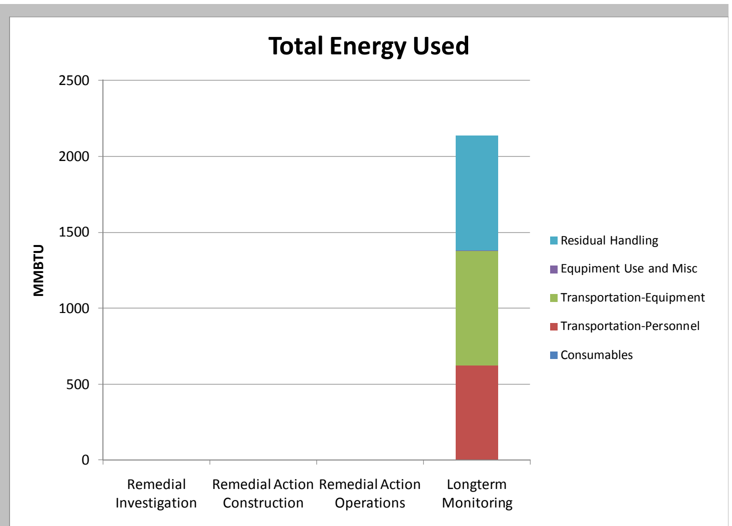
Long-Term Monitoring (MNA)

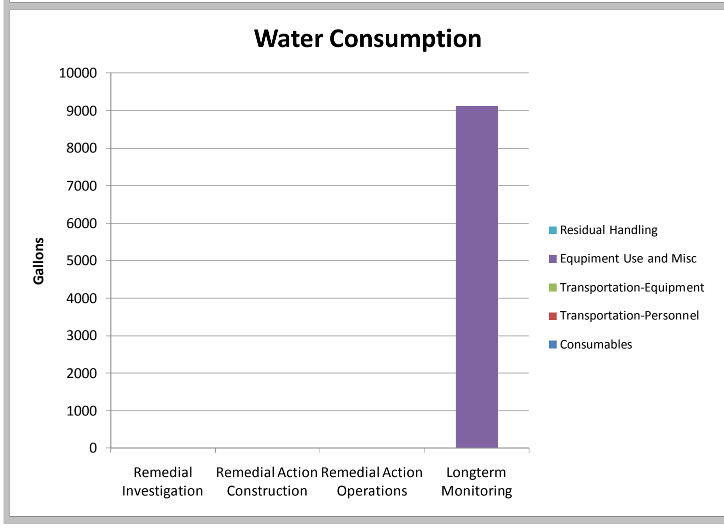
208-Year Scenario

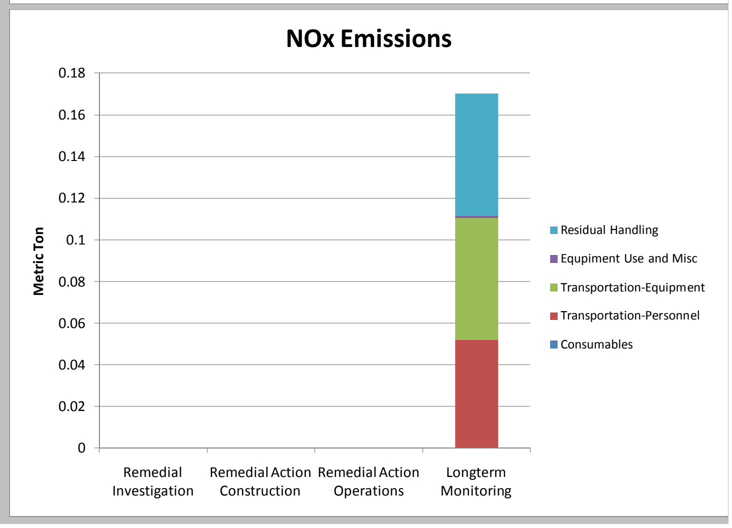
Sustainable Remediation - Environmental Footprint Summary
LTM (MNA)

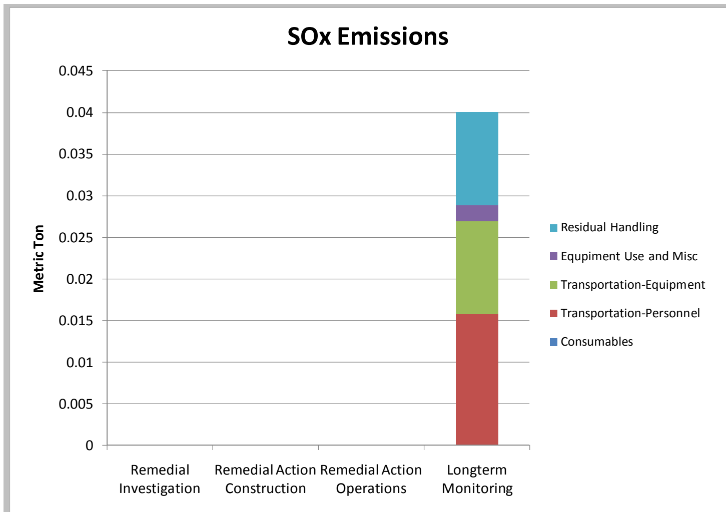
Phase	Activities	GHG Emissions (metric ton)	Total energy Used (MMBTU)	Water Consumption (gallons)	NOx emissions (metric ton)	SOx Emissions (metric ton)	PM10 Emissions (metric ton)	Accident Risk Fatality	Accident Risk Injury
Remedial Investigation	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Remedial Action Construction	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Remedial Action Operations	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Longterm Monitoring	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	61.44	6.2E+02	NA	5.2E-02	1.6E-02	1.0E-02	1.6E-03	1.2E-01
	Transportation-Equipment	51.43	7.5E+02	NA	5.8E-02	1.1E-02	5.5E-03	1.0E-04	2.2E-02
	Equipment Use and Misc	0.55	6.4E+00	9.1E+03	1.1E-03	1.9E-03	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	51.54	7.5E+02	NA	5.9E-02	1.1E-02	5.5E-03	1.6E-04	3.4E-02
	Sub-Total	164.96	2.14E+03	9.12E+03	1.70E-01	4.01E-02	2.11E-02	1.89E-03	1.72E-01
Total		**1.6E+02**	**2.1E+03**	**9.1E+03**	**1.7E-01**	**4.0E-02**	**2.1E-02**	**1.9E-03**	**1.7E-01**

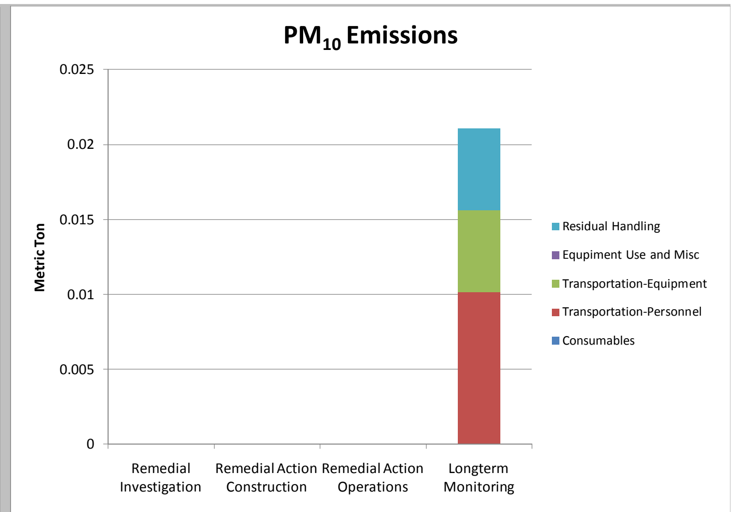

GHG Emissions
Metric Tons
180
160
140
120
100
80
60
40
20
0
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

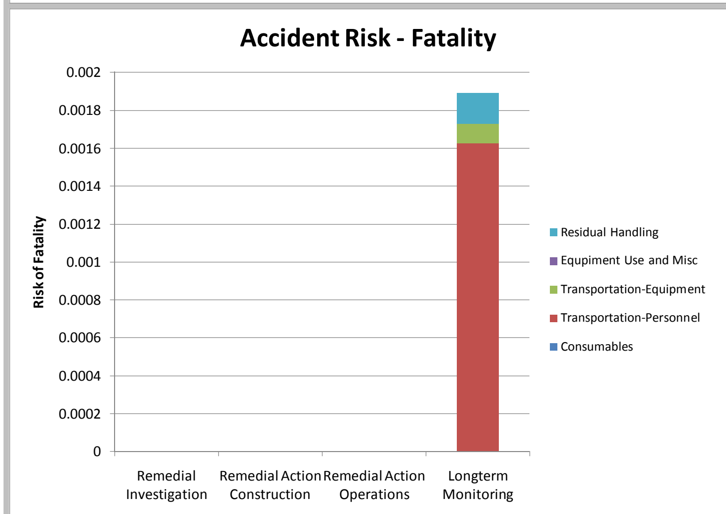

Total Energy Used
MMBTU
2500
2000
1500
1000
500
0
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

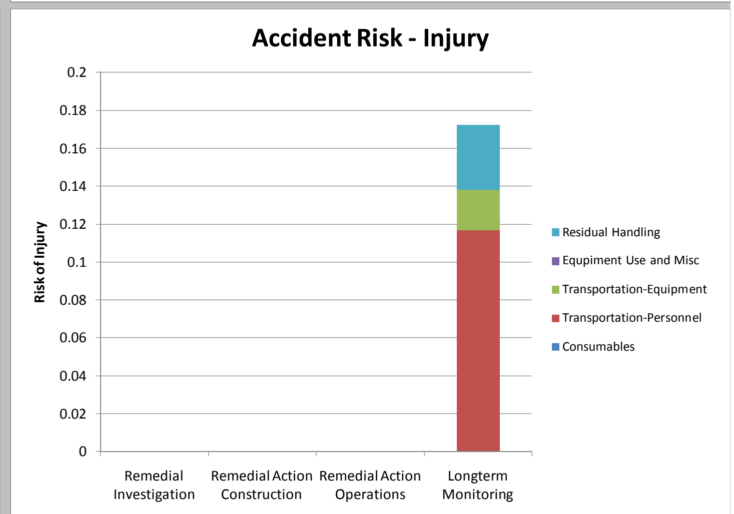

Water Consumption
Gallons
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


NOx Emissions
Metric Ton
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


SOx Emissions
Metric Ton
0.045
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


PM_{10} Emissions
Metric Ton
0.025
0.02
0.015
0.01
0.005
0
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


Accident Risk - Fatality
Risk of Fatality
0.002
0.0018
0.0016
0.0014
0.0012
0.001
0.0008
0.0006
0.0004
0.0002
0
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

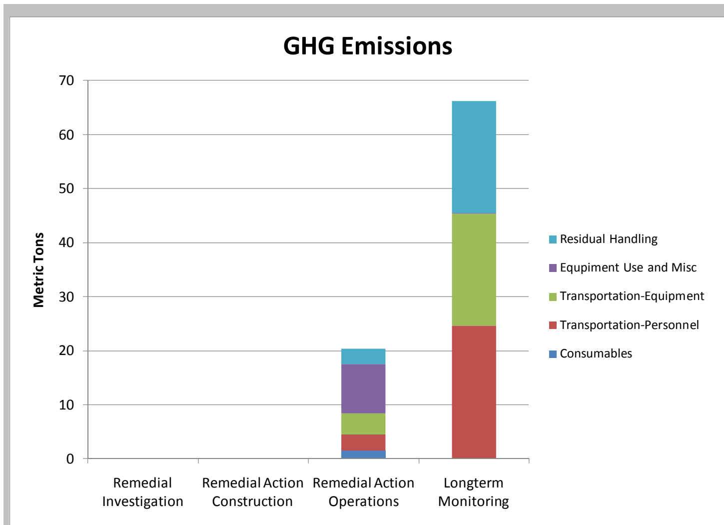

Accident Risk - Injury
Risk of Injury
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

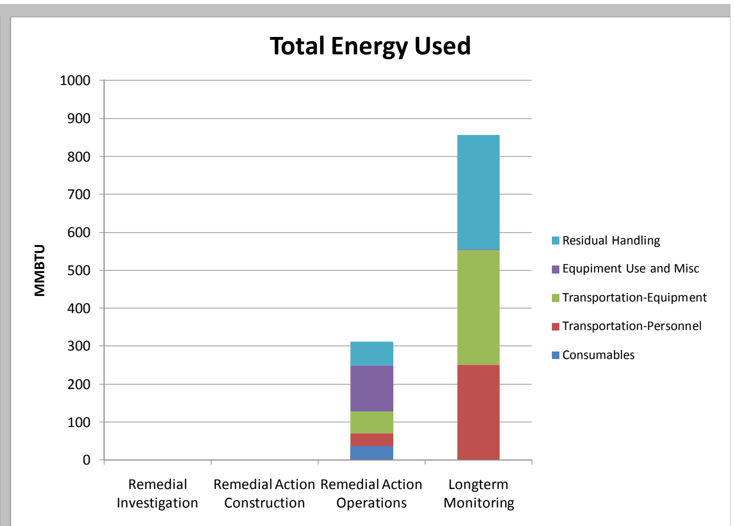
Enhanced Anaerobic Bioremediation

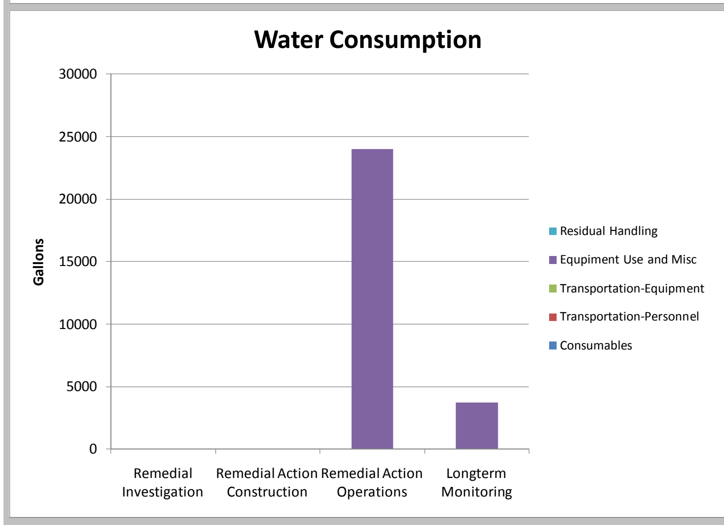
78-Year Scenario

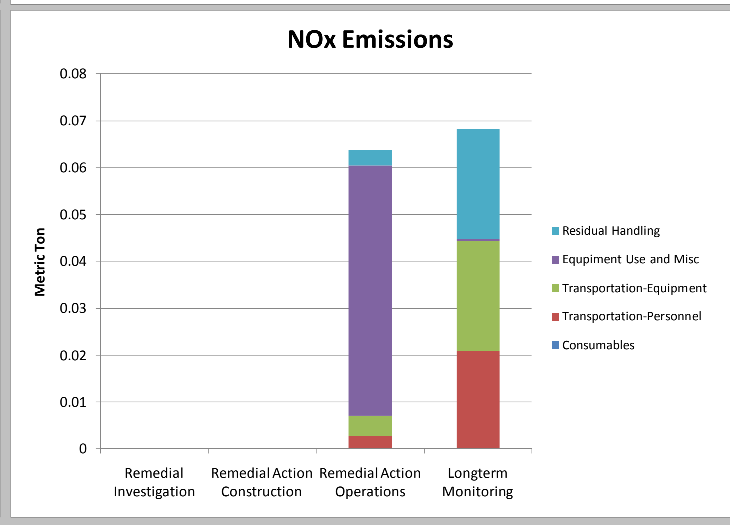
Sustainable Remediation - Environmental Footprint Summary
Enhanced Bio

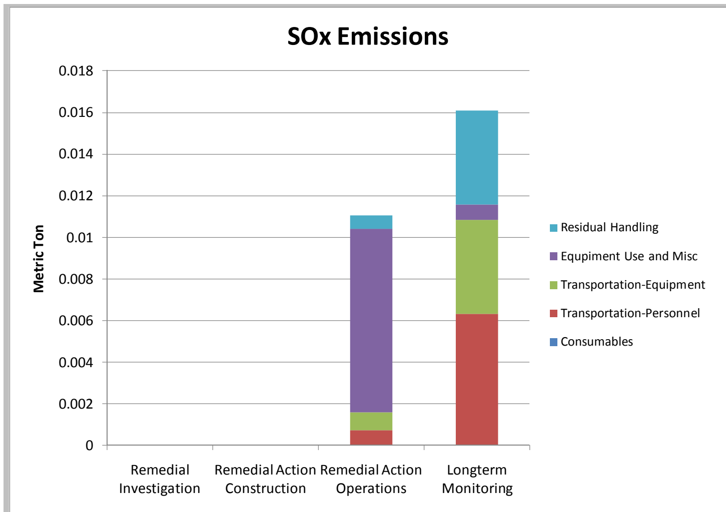
Phase	Activities	GHG Emissions (metric ton)	Total energy Used (MMBTU)	Water Consumption (gallons)	NOx emissions (metric ton)	SOx Emissions (metric ton)	PM10 Emissions (metric ton)	Accident Risk Fatality	Accident Risk Injury
Remedial Investigation	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Remedial Action Construction	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Remedial Action Operations	Consumables	1.54	3.8E+01	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	2.97	3.2E+01	NA	2.7E-03	7.4E-04	4.6E-04	7.9E-05	5.7E-03
	Transportation-Equipment	3.93	5.8E+01	NA	4.5E-03	8.6E-04	4.2E-04	7.9E-06	1.6E-03
	Equipment Use and Misc	9.01	1.2E+02	2.4E+04	5.3E-02	8.8E-03	4.0E-03	6.7E-05	2.9E-02
	Residual Handling	2.85	6.1E+01	NA	3.2E-03	6.2E-04	3.0E-04	9.1E-06	1.9E-03
	Sub-Total	20.31	3.11E+02	2.40E+04	6.38E-02	1.10E-02	5.22E-03	1.62E-04	3.78E-02
Longterm Monitoring	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	24.68	2.5E+02	NA	2.1E-02	6.3E-03	4.1E-03	6.5E-04	4.7E-02
	Transportation-Equipment	20.62	3.0E+02	NA	2.3E-02	4.5E-03	2.2E-03	4.2E-05	8.7E-03
	Equipment Use and Misc	0.23	2.6E+00	3.7E+03	4.4E-04	7.6E-04	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	20.66	3.0E+02	NA	2.3E-02	4.5E-03	2.2E-03	6.6E-05	1.4E-02
	Sub-Total	66.19	8.57E+02	3.74E+03	6.83E-02	1.61E-02	8.45E-03	7.60E-04	6.92E-02
Total		**8.6E+01**	**1.2E+03**	**2.8E+04**	**1.3E-01**	**2.7E-02**	**1.4E-02**	**9.2E-04**	**1.1E-01**

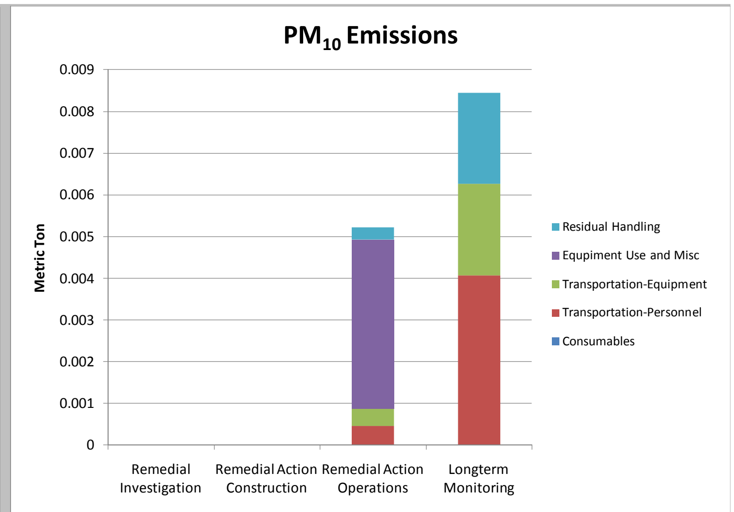

GHG Emissions
Metric Tons
0
10
20
30
40
50
60
70
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

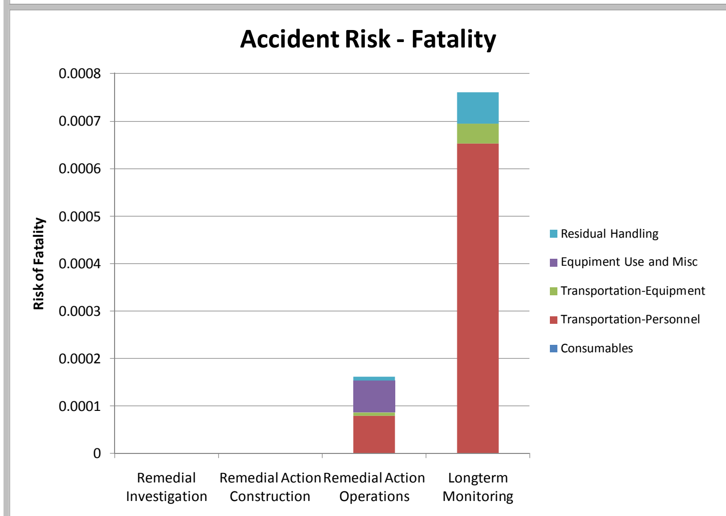

Total Energy Used
MMBTU
0
100
200
300
400
500
600
700
800
900
1000
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

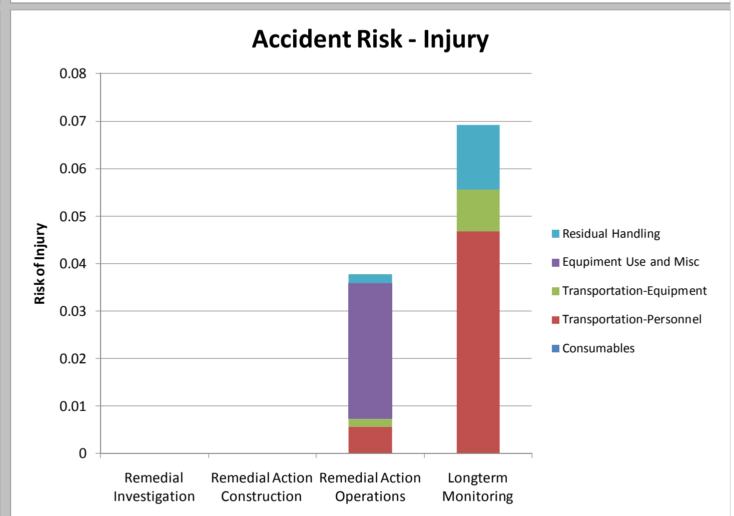

Water Consumption
Gallons
0
5000
10000
15000
20000
25000
30000
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


NOx Emissions
Metric Ton
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


SOx Emissions
Metric Ton
0.018
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


PM_{10} Emissions
Metric Ton
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


Accident Risk - Fatality
Risk of Fatality
0.0008
0.0007
0.0006
0.0005
0.0004
0.0003
0.0002
0.0001
0
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

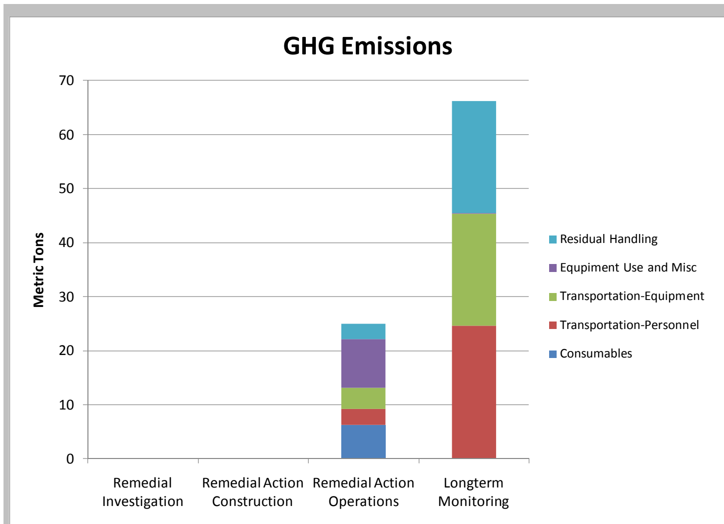

Accident Risk - Injury
Risk of Injury
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

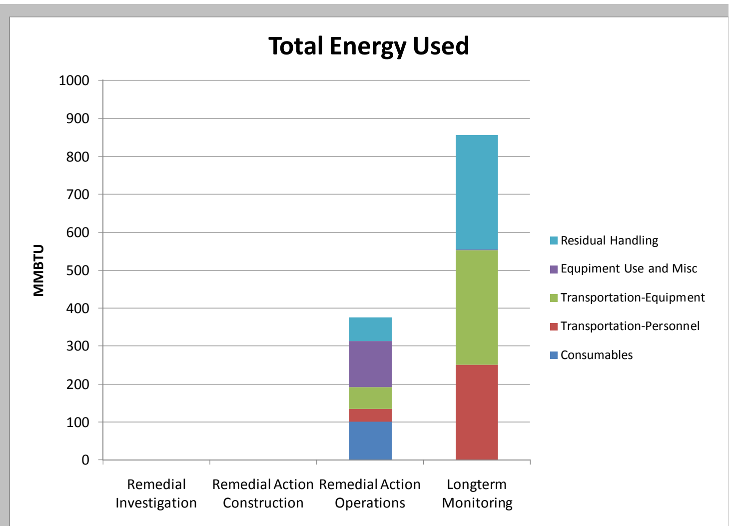
In-Situ Chemical Oxidation

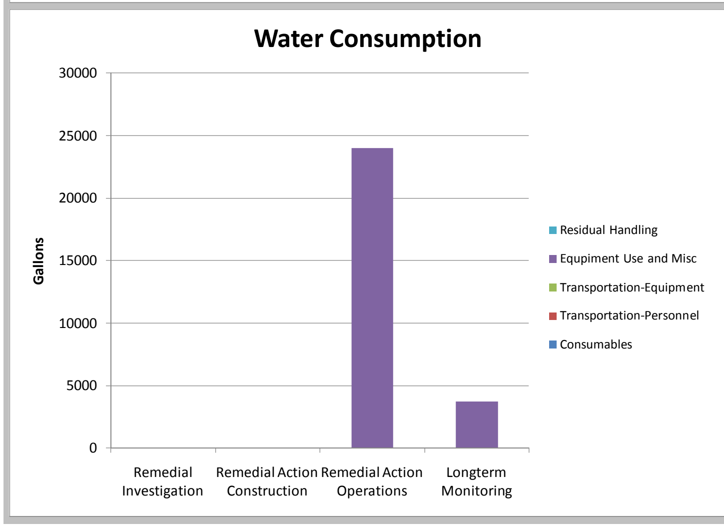
78-Year Scenario

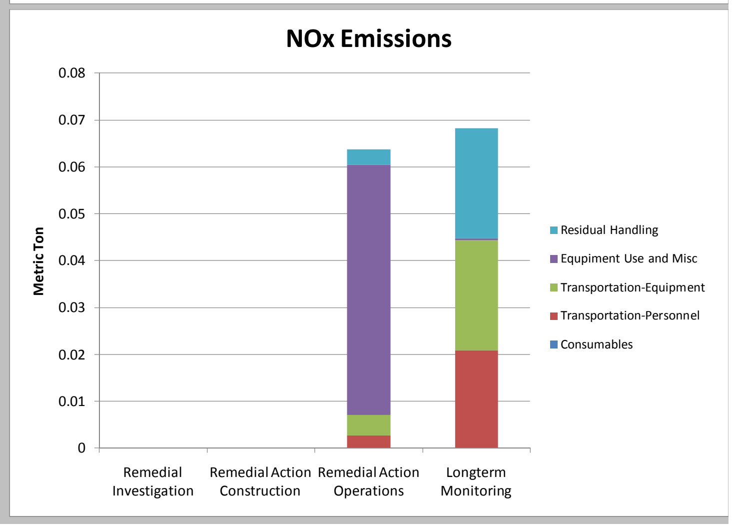
Sustainable Remediation - Environmental Footprint Summary
ISCO

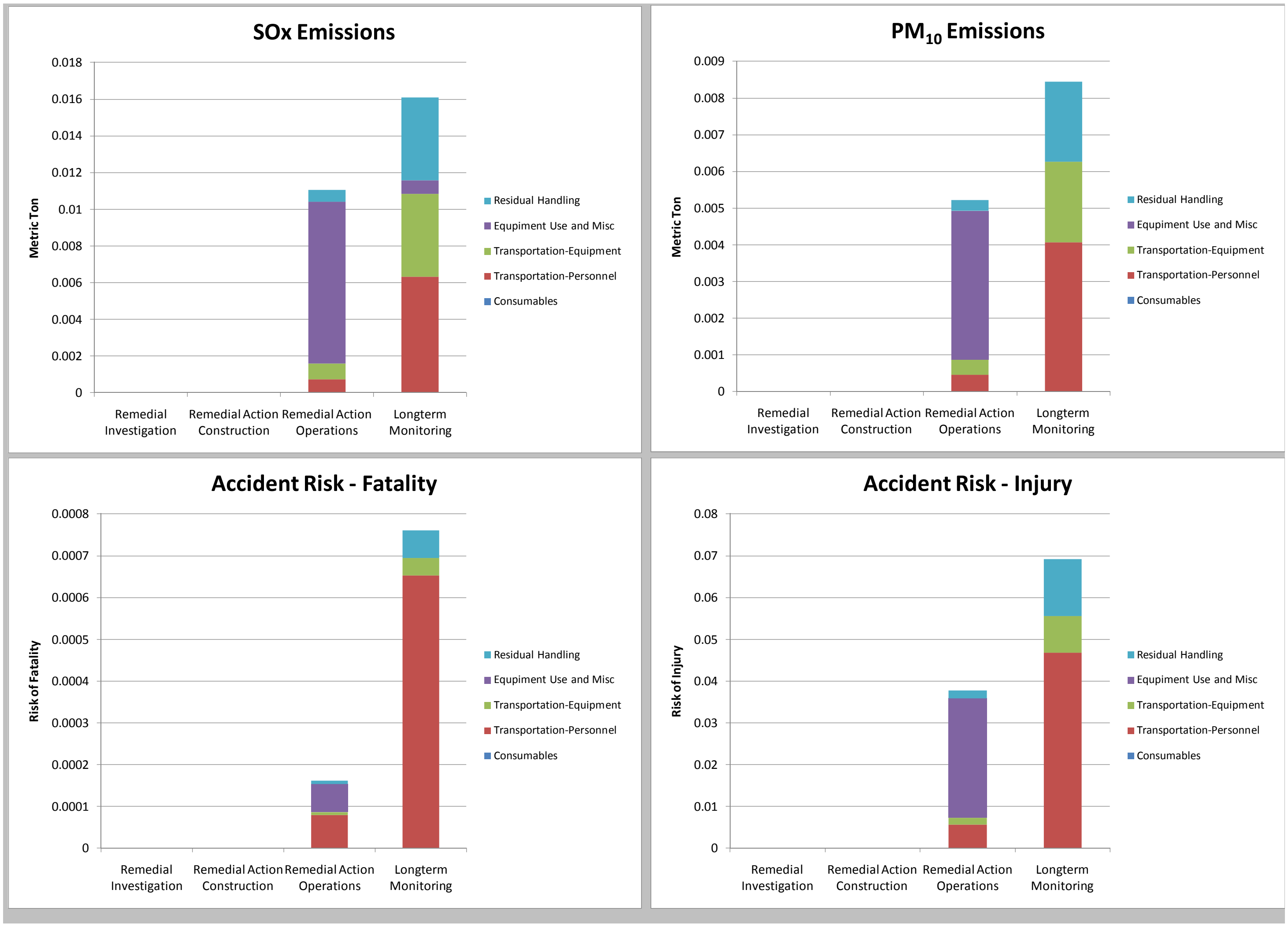
Phase	Activities	GHG Emissions (metric ton)	Total energy Used (MMBTU)	Water Consumption (gallons)	NOx emissions (metric ton)	SOx Emissions (metric ton)	PM10 Emissions (metric ton)	Accident Risk Fatality	Accident Risk Injury
Remedial Investigation	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Remedial Action Construction	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Remedial Action Operations	Consumables	6.27	1.0E+02	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	2.97	3.2E+01	NA	2.7E-03	7.4E-04	4.6E-04	7.9E-05	5.7E-03
	Transportation-Equipment	3.93	5.8E+01	NA	4.5E-03	8.6E-04	4.2E-04	7.9E-06	1.6E-03
	Equipment Use and Misc	9.01	1.2E+02	2.4E+04	5.3E-02	8.8E-03	4.0E-03	6.7E-05	2.9E-02
	Residual Handling	2.85	6.1E+01	NA	3.2E-03	6.2E-04	3.0E-04	9.1E-06	1.9E-03
	Sub-Total	25.04	3.75E+02	2.40E+04	6.38E-02	1.10E-02	5.22E-03	1.62E-04	3.78E-02
Longterm Monitoring	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	24.68	2.5E+02	NA	2.1E-02	6.3E-03	4.1E-03	6.5E-04	4.7E-02
	Transportation-Equipment	20.62	3.0E+02	NA	2.3E-02	4.5E-03	2.2E-03	4.2E-05	8.7E-03
	Equipment Use and Misc	0.23	2.6E+00	3.7E+03	4.4E-04	7.6E-04	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	20.66	3.0E+02	NA	2.3E-02	4.5E-03	2.2E-03	6.6E-05	1.4E-02
	Sub-Total	66.19	8.57E+02	3.74E+03	6.83E-02	1.61E-02	8.45E-03	7.60E-04	6.92E-02
Total		**9.1E+01**	**1.2E+03**	**2.8E+04**	**1.3E-01**	**2.7E-02**	**1.4E-02**	**9.2E-04**	**1.1E-01**


GHG Emissions
Metric Tons
70
60
50
40
30
20
10
0
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


Total Energy Used
MMBTU
1000
900
800
700
600
500
400
300
200
100
0
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


Water Consumption
Gallons
30000
25000
20000
15000
10000
5000
0
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


NOx Emissions
Metric Ton
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


SOx Emissions
Metric Ton
0.018
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables
PM_{10} Emissions
Metric Ton
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables
Accident Risk - Fatality
Risk of Fatality
0.0008
0.0007
0.0006
0.0005
0.0004
0.0003
0.0002
0.0001
0
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables
Accident Risk - Injury
Risk of Injury
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

Attachment 3

Detailed Costs for the Different Alternatives and Time Frames

Table A3-1 Cost Estimate for Long-Term Monitoring, 30 year time period

Year	Fiscal Year	Remedial Action and Monitoring Costs($)	Monitoring Well Abandonment Costs($)	O&M Costs ($)	5-Year Review Costs ($)	Total Costs ($)	Discount with R at 2.7%	Total Present Value Cost ($)
0 FY	11	$146,888	$0	$0	$0	$146,888	1.000	$146,888
1 FY	12	$92,423	$0	$0	$0	$92,423	0.974	$89,993
2 FY	13	$33,650	$0	$0	$0	$33,650	0.948	$31,904
3 FY	14	$33,650	$0	$0	$0 $33,	650	0.923	$31,065
4 FY	15	$33,650	$0	$0	$0	$33,650	0.899	$30,248
5 FY	16	$19,884	$0	$0	$35,503	$55,387	0.875	$48,479
6 FY	17	$19,884	$0	$0	$0	$19,884	0.852	$16,947
7 FY	18	$19,884	$0	$0	$0	$19,884	0.830	$16,501
8 FY	19	$19,884	$0	$0	$0 $19,	884	0.808	$16,067
9 FY	20	$19,884	$0	$0	$0	$19,884	0.787	$15,645
10 FY	21	$19,884	$0	$0	$35,503	$55,387	0.766	$42,433
11 FY	22	$19,884	$0	$0	$0	$19,884	0.746	$14,833
12 FY	23	$19,884	$0	$0	$0	$19,884	0.726	$14,443
13 FY	24	$19,884	$0	$0	$0 $19,	884	0.707	$14,063
14 FY	25	$19,884	$0	$0	$0	$19,884	0.689	$13,694
15 FY	26	$19,884	$0	$0	$35,503	$55,387	0.671	$37,141
16 FY	27	$19,884	$0	$0	$0	$19,884	0.653	$12,983
17 FY	28	$19,884	$0	$0	$0	$19,884	0.636	$12,642
18 FY	29	$19,884	$0	$0	$0 $19,	884	0.619	$12,309
19 FY	30	$19,884	$0	$0	$0	$19,884	0.603	$11,986
20 FY	31	$19,884	$0	$0	$35,503	$55,387	0.587	$32,508
21 FY	32	$19,884	$0	$0	$0	$19,884	0.572	$11,364
22 FY	33	$19,884	$0	$0	$0	$19,884	0.556	$11,065
23 FY	34	$19,884	$0	$0	$0 $19,	884	0.542	$10,774
24 FY	35	$19,884	$0	$0	$0	$19,884	0.528	$10,491
25 FY	36	$19,884	$0	$0	$35,503	$55,387	0.514	$28,454
26 FY	37	$19,884	$0	$0	$0	$19,884	0.500	$9,947
27 FY	38	$19,884	$0	$0	$0	$19,884	0.487	$9,685
28 FY	39	$19,884	$0	$0	$0	$19,884	0.474	$9,430
29 FY	40	$19,884	$25,345	$0	$0	$45,229	0.462	$20,887
Total		$837,362	$25,345	$0	$177,513	$1,040,220		$784,869

Table A3-2 Cost Estimate for EAB/MNA/LTM, 30 year time period								
Year	Fiscal Year	Remedial Action and Monitoring Costs ($)	Monitoring Well Abandonment Costs ($)	O&M Costs ($)	5-Year Review Costs ($)	Total Costs ($)	Discount with R at 2.7%	Total Present Value Cost ($)
0 FY	11	$1,738,548 $0		$0 $0		$1,738,548	1.000	$1,738,548
1 FY	12	$158,195 $	0	$1,495,204 $0		$1,653,399	0.974	$1,609,931
2 FY	13	$67,353 $0		$1,495,204 $0		$1,562,557	0.948	$1,481,477
3 FY	14	$67,353 $0		$1,495,204	$0 $1,	562,557	0.923	$1,442,529
4 FY	15	$33,650	$0	$0 $0		$33,650	0.899	$30,248
5 FY	16	$19,884	$0	$0 $38,	553	$58,437	0.875	$51,149
6 FY	17	$19,884	$0	$0 $0		$19,884	0.852	$16,947
7 FY	18	$19,884	$0	$0 $0		$19,884	0.830	$16,501
8 FY	19	$19,884	$0	$0 $0		$19,884	0.808	$16,067
9 FY	20	$19,884	$0	$0 $0		$19,884	0.787	$15,645
10 FY	21	$19,884	$0	$0 $38,	553	$58,437	0.766	$44,770
11 FY	22	$19,884	$0	$0 $0		$19,884	0.746	$14,833
12 FY	23	$19,884	$0	$0 $0		$19,884	0.726	$14,443
13 FY	24	$19,884	$0	$0 $0		$19,884	0.707	$14,063
14 FY	25	$19,884	$0	$0 $0		$19,884	0.689	$13,694
15 FY	26	$19,884	$0	$0 $38,	553	$58,437	0.671	$39,186
16 FY	27	$19,884	$0	$0 $0		$19,884	0.653	$12,983
17 FY	28	$19,884	$0	$0 $0		$19,884	0.636	$12,642
18 FY	29	$19,884	$0	$0 $0		$19,884	0.619	$12,309
19 FY	30	$19,884	$0	$0 $0		$19,884	0.603	$11,986
20 FY	31	$19,884	$0	$0 $38,	553	$58,437	0.587	$34,299
21 FY	32	$19,884	$0	$0 $0		$19,884	0.572	$11,364
22 FY	33	$19,884	$0	$0 $0		$19,884	0.556	$11,065
23 FY	34	$19,884	$0	$0 $0		$19,884	0.542	$10,774
24 FY	35	$19,884	$0	$0 $0		$19,884	0.528	$10,491
25 FY	36	$19,884	$0	$0 $38,	553	$58,437	0.514	$30,021
26 FY	37	$19,884	$0	$0 $0		$19,884	0.500	$9,947
27 FY	38	$19,884	$0	$0 $0		$19,884	0.487	$9,685
28 FY	39	$19,884	$0	$0 $0		$19,884	0.474	$9,430
29 FY	40	$19,884	$25,345	$0 $0		$45,229	0.462	$20,887
Total		$2,562,199	$25,345	$4,485,612	$192,765	$7,265,922		$6,767,914

Table A3-3 Cost Estimate for ISCO/LTM, 30 year time period

Year	Fiscal Year	Remedial Action and Monitoring Costs ($)	Monitoring Well Abandonment Costs ($)	O&M Costs ($)	5-Year Review Costs ($)	Total Costs ($)	Discount with R a 2.7%	Total Present Value Cost ($)
0 FY	11	$2,062,229 $0		$0 $0		$2,062,229	1.000	$2,062,229
1 FY	12	$158,195 $	0	$1,522,131 $0		$1,680,326	0.974	$1,636,150
2 FY	13	$33,650	$0	$1,522,131 $0		$1,555,781	0.948	$1,475,053
3 FY	14	$33,650	$0	$1,522,131	$0 $1,	555,781	0.923	$1,436,273
4 FY	15	$33,650	$0	$0 $0		$33,650	0.899	$30,248
5 FY	16	$19,884	$0	$0 $38,	553	$58,437	0.875	$51,149
6 FY	17	$19,884	$0	$0 $0		$19,884	0.852	$16,947
7 FY	18	$19,884	$0	$0 $0		$19,884	0.830	$16,501
8 FY	19	$19,884	$0	$0 $0		$19,884	0.808	$16,067
9 FY	20	$19,884	$0	$0 $0		$19,884	0.787	$15,645
10 FY	21	$19,884	$0	$0 $38,	553	$58,437	0.766	$44,770
11 FY	22	$19,884	$0	$0 $0		$19,884	0.746	$14,833
12 FY	23	$19,884	$0	$0 $0		$19,884	0.726	$14,443
13 FY	24	$19,884	$0	$0 $0		$19,884	0.707	$14,063
14 FY	25	$19,884	$0	$0 $0		$19,884	0.689	$13,694
15 FY	26	$19,884	$0	$0 $38,	553	$58,437	0.671	$39,186
16 FY	27	$19,884	$0	$0 $0		$19,884	0.653	$12,983
17 FY	28	$19,884	$0	$0 $0		$19,884	0.636	$12,642
18 FY	29	$19,884	$0	$0 $0		$19,884	0.619	$12,309
19 FY	30	$19,884	$0	$0 $0		$19,884	0.603	$11,986
20 FY	31	$19,884	$0	$0 $38,	553	$58,437	0.587	$34,299
21 FY	32	$19,884	$0	$0 $0		$19,884	0.572	$11,364
22 FY	33	$19,884	$0	$0 $0		$19,884	0.556	$11,065
23 FY	34	$19,884	$0	$0 $0		$19,884	0.542	$10,774
24 FY	35	$19,884	$0	$0 $0		$19,884	0.528	$10,491
25 FY	36	$19,884	$0	$0 $38,	553	$58,437	0.514	$30,021
26 FY	37	$19,884	$0	$0 $0		$19,884	0.500	$9,947
27 FY	38	$19,884	$0	$0 $0		$19,884	0.487	$9,685
28 FY	39	$19,884	$0	$0 $0		$19,884	0.474	$9,430
29 FY	40	$19,884	$25,345	$0 $0		$45,229	0.462	$20,887
Total		$2,818,475	$25,345	$4,566,393	$192,765	$7,602,978		$7,105,134

Table A3-4 Cost Estimate for Long-Term Monitoring, 208 year (remediation closeout) time period								
Year	Fiscal Year	Remedial Action and Monitoring Costs ($)	Monitoring Well Abandonment Costs ($)	O&M Costs ($)	5-Year Review Costs ($)	Total Costs ($)	Discount with R at 2.7%	Total Present Value Cost ($)
0 FY	1	$146,888	$0	$0	$0	$146,888	1.000	$146,888
1 FY	2	$92,423	$0	$0	$0	$92,423	0.974	$89,993
2 FY	3	$33,650	$0	$0	$0	$33,650	0.948	$31,904
3 FY	4	$33,650	$0	$0	$0 $33,	650	0.923	$31,065
4 FY	5	$33,650	$0	$0	$0	$33,650	0.899	$30,248
5 FY	6	$19,884	$0	$0	$35,503	$55,387	0.875	$48,479
6 FY	7	$19,884	$0	$0	$0	$19,884	0.852	$16,947
7 FY	8	$19,884	$0	$0	$0	$19,884	0.830	$16,501
8 FY	9	$19,884	$0	$0	$0 $19,	884	0.808	$16,067
9 FY	20	$19,884	$0	$0	$0	$19,884	0.787	$15,645
10 FY	21	$19,884	$0	$0	$35,503	$55,387	0.766	$42,433
11 FY	22	$19,884	$0	$0	$0	$19,884	0.746	$14,833
12 FY	23	$19,884	$0	$0	$0	$19,884	0.726	$14,443
13 FY	24	$19,884	$0	$0	$0 $19,	884	0.707	$14,063
14 FY	25	$19,884	$0	$0	$0	$19,884	0.689	$13,694
15 FY	26	$19,884	$0	$0	$35,503	$55,387	0.671	$37,141
16 FY	27	$19,884	$0	$0	$0	$19,884	0.653	$12,983
17 FY	28	$19,884	$0	$0	$0	$19,884	0.636	$12,642
18 FY	29	$19,884	$0	$0	$0 $19,	884	0.619	$12,309
19 FY	30	$19,884	$0	$0	$0	$19,884	0.603	$11,986
20 FY	31	$19,884	$0	$0	$35,503	$55,387	0.587	$32,508
21 FY	32	$19,884	$0	$0	$0	$19,884	0.572	$11,364
22 FY	33	$19,884	$0	$0	$0	$19,884	0.556	$11,065
23 FY	34	$19,884	$0	$0	$0 $19,	884	0.542	$10,774
24 FY	35	$19,884	$0	$0	$0	$19,884	0.528	$10,491
25 FY	36	$19,884	$0	$0	$35,503	$55,387	0.514	$28,454
26 FY	37	$19,884	$0	$0	$0	$19,884	0.500	$9,947
27 FY	38	$19,884	$0	$0	$0	$19,884	0.487	$9,685
28 FY	39	$19,884	$0	$0	$0 $19,	884	0.474	$9,430
29 FY	40	$19,884	$0	$0	$0	$19,884	0.462	$9,183
30 FY	41	$19,884	$0	$0	$35,503	$55,387	0.450	$24,905
31 FY	42	$19,884	$0	$0	$0	$19,884	0.438	$8,706
32 FY	43	$19,884	$0	$0	$0	$19,884	0.426	$8,477
33 FY	44	$19,884	$0	$0	$0 $19,	884	0.415	$8,254
34 FY	45	$19,884	$0	$0	$0	$19,884	0.404	$8,037
35 FY	46	$19,884	$0	$0	$35,503	$55,387	0.394	$21,799

Table A3-4 Cost Estimate for Long-Term Monitoring, 208 year (remediation closeout) time period **cont.**								
Year	Fiscal Year	Remedial Action and Monitoring Costs ($)	Monitoring Well Abandonment Costs ($)	O&M Costs ($)	5-Year Review Costs ($)	Total Costs ($)	Discount with R at 2.7%	Total Present Value Cost ($)
36 FY	47	$19,884	$0	$0	$0	$19,884	0.383	$7,620
37 FY	48	$19,884	$0	$0	$0	$19,884	0.373	$7,420
38 FY	49	$19,884	$0	$0	$0 $19,	884	0.363	$7,225
39 FY	50	$19,884	$0	$0	$0	$19,884	0.354	$7,035
40 FY	51	$19,884	$0	$0	$35,503	$55,387	0.344	$19,080
41 FY	52	$19,884	$0	$0	$0	$19,884	0.335	$6,670
42 FY	53	$19,884	$0	$0	$0	$19,884	0.327	$6,495
43 FY	54	$19,884	$0	$0	$0 $19,	884	0.318	$6,324
44 FY	55	$19,884	$0	$0	$0	$19,884	0.310	$6,158
45 FY	56	$19,884	$0	$0	$35,503	$55,387	0.302	$16,701
46 FY	57	$19,884	$0	$0	$0	$19,884	0.294	$5,838
47 FY	58	$19,884	$0	$0	$0	$19,884	0.286	$5,685
48 FY	59	$19,884	$0	$0	$0 $19,	884	0.278	$5,535
49 FY	60	$19,884	$0	$0	$0	$19,884	0.271	$5,390
50 FY	61	$19,884	$0	$0	$35,503	$55,387	0.264	$14,618
51 FY	62	$19,884	$0	$0	$0	$19,884	0.257	$5,110
52 FY	63	$19,884	$0	$0	$0	$19,884	0.250	$4,976
53 FY	64	$19,884	$0	$0	$0 $19,	884	0.244	$4,845
54 FY	65	$19,884	$0	$0	$0	$19,884	0.237	$4,717
55 FY	66	$19,884	$0	$0	$35,503	$55,387	0.231	$12,795
56 FY	67	$19,884	$0	$0	$0	$19,884	0.225	$4,473
57 FY	68	$19,884	$0	$0	$0	$19,884	0.219	$4,355
58 FY	69	$19,884	$0	$0	$0 $19,	884	0.213	$4,241
59 FY	70	$19,884	$0	$0	$0	$19,884	0.208	$4,129
60 FY	71	$19,884	$0	$0	$35,503	$55,387	0.202	$11,199
61 FY	72	$19,884	$0	$0	$0	$19,884	0.197	$3,915
62 FY	73	$19,884	$0	$0	$0	$19,884	0.192	$3,812
63 FY	74	$19,884	$0	$0	$0 $19,	884	0.187	$3,712
64 FY	75	$19,884	$0	$0	$0	$19,884	0.182	$3,614
65 FY	76	$19,884	$0	$0	$35,503	$55,387	0.177	$9,802
66 FY	77	$19,884	$0	$0	$0	$19,884	0.172	$3,427
67 FY	78	$19,884	$0	$0	$0	$19,884	0.168	$3,336
68 FY	79	$19,884	$0	$0	$0 $19,	884	0.163	$3,249
69 FY	80	$19,884	$0	$0	$0	$19,884	0.159	$3,163
70 FY	81	$19,884	$0	$0	$35,503	$55,387	0.155	$8,580
71 FY	82	$19,884	$0	$0	$0	$19,884	0.151	$2,999
72 FY	83	$19,884	$0	$0	$0	$19,884	0.147	$2,920

Table A3-4 Cost Estimate for Long-Term Monitoring, 208 year (remediation closeout) time period **cont.**								
Year	Fiscal Year	Remedial Action and Monitoring Costs ($)	Monitoring Well Abandonment Costs ($)	O&M Costs ($)	5-Year Review Costs ($)	Total Costs ($)	Discount with R at 2.7%	Total Present Value Cost ($)
73 FY	84	$19,884	$0	$0	$0 $19,	884	0.143	$2,844
74 FY	85	$19,884	$0	$0	$0	$19,884	0.139	$2,769
75 FY	86	$19,884	$0	$0	$35,503	$55,387	0.136	$7,510
76 FY	87	$19,884	$0	$0	$0	$19,884	0.132	$2,625
77 FY	88	$19,884	$0	$0	$0	$19,884	0.129	$2,556
78 FY	89	$19,884	$0	$0	$0 $19,	884	0.125	$2,489
79 FY	90	$19,884	$0	$0	$0	$19,884	0.122	$2,423
80 FY	91	$19,884	$0	$0	$35,503	$55,387	0.119	$6,573
81 FY	92	$19,884	$0	$0	$0	$19,884	0.116	$2,298
82 FY	93	$19,884	$0	$0	$0	$19,884	0.113	$2,237
83 FY	94	$19,884	$0	$0	$0 $19,	884	0.110	$2,179
84 FY	95	$19,884	$0	$0	$0	$19,884	0.107	$2,121
85 FY	96	$19,884	$0	$0	$35,503	$55,387	0.104	$5,753
86 FY	97	$19,884	$0	$0	$0	$19,884	0.101	$2,011
87 FY	98	$19,884	$0	$0	$0	$19,884	0.098	$1,958
88 FY	99	$19,884	$0	$0	$0 $19,	884	0.096	$1,907
89 FY	100	$19,884	$0	$0	$0	$19,884	0.093	$1,857
90 FY	101	$19,884	$0	$0	$35,503	$55,387	0.091	$5,036
91 FY	102	$19,884	$0	$0	$0	$19,884	0.089	$1,760
92 FY	103	$19,884	$0	$0	$0	$19,884	0.086	$1,714
93 FY	104	$19,884	$0	$0	$0 $19,	884	0.084	$1,669
94 FY	105	$19,884	$0	$0	$0	$19,884	0.082	$1,625
95 FY	106	$19,884	$0	$0	$35,503	$55,387	0.080	$4,408
96 FY	107	$19,884	$0	$0	$0	$19,884	0.077	$1,541
97 FY	108	$19,884	$0	$0	$0	$19,884	0.075	$1,500
98 FY	109	$19,884	$0	$0	$0 $19,	884	0.073	$1,461
99 FY	110	$19,884	$0	$0	$0	$19,884	0.072	$1,422
100 FY	111	$19,884	$0	$0	$35,503	$55,387	0.070	$3,858
101 FY	112	$19,884	$0	$0	$0	$19,884	0.068	$1,349
102 FY	113	$19,884	$0	$0	$0	$19,884	0.066	$1,313
103 FY	114	$19,884	$0	$0	$0 $19,	884	0.064	$1,279
104 FY	115	$19,884	$0	$0	$0	$19,884	0.063	$1,245
105 FY	116	$19,884	$0	$0	$35,503	$55,387	0.061	$3,377
106 FY	117	$19,884	$0	$0	$0	$19,884	0.059	$1,180
107 FY	118	$19,884	$0	$0	$0	$19,884	0.058	$1,149
108 FY	119	$19,884	$0	$0	$0 $19,	884	0.056	$1,119

Table A3-4 Cost Estimate for Long-Term Monitoring, 208 year (remediation closeout) time period **cont.**

Year	Fiscal Year	Remedial Action and Monitoring Costs ($)	Monitoring Well Abandonment Costs ($)	O&M Costs ($)	5-Year Review Costs ($)	Total Costs ($)	Discount with R at 2.7%	Total Present Value Cost ($)
109	FY120	$19,884	$0	$0	$0	$19,884	0.055	$1,090
110	FY121	$19,884	$0	$0	$35,503	$55,387	0.053	$2,956
111	FY122	$19,884	$0	$0	$0	$19,884	0.052	$1,033
112	FY123	$19,884	$0	$0	$0	$19,884	0.051	$1,006
113	FY124	$19,884	$0	$0	$0 $19,	884	0.049	$980
114	FY125	$19,884	$0	$0	$0	$19,884	0.048	$954
115	FY126	$19,884	$0	$0	$35,503	$55,387	0.047	$2,587
116	FY127	$19,884	$0	$0	$0	$19,884	0.045	$904
117	FY128	$19,884	$0	$0	$0	$19,884	0.044	$881
118	FY129	$19,884	$0	$0	$0 $19,	884	0.043	$857
119	FY130	$19,884	$0	$0	$0	$19,884	0.042	$835
120	FY131	$19,884	$0	$0	$35,503	$55,387	0.041	$2,264
121	FY132	$19,884	$0	$0	$0	$19,884	0.040	$792
122	FY133	$19,884	$0	$0	$0	$19,884	0.039	$771
123	FY134	$19,884	$0	$0	$0 $19,	884	0.038	$750
124	FY135	$19,884	$0	$0	$0	$19,884	0.037	$731
125	FY136	$19,884	$0	$0	$35,503	$55,387	0.036	$1,982
126	FY137	$19,884	$0	$0	$0	$19,884	0.035	$693
127	FY138	$19,884	$0	$0	$0	$19,884	0.034	$675
128	FY139	$19,884	$0	$0	$0 $19,	884	0.033	$657
129	FY140	$19,884	$0	$0	$0	$19,884	0.032	$640
130	FY141	$19,884	$0	$0	$35,503	$55,387	0.031	$1,735
131	FY142	$19,884	$0	$0	$0	$19,884	0.030	$606
132	FY143	$19,884	$0	$0	$0	$19,884	0.030	$590
133	FY144	$19,884	$0	$0	$0 $19,	884	0.029	$575
134	FY145	$19,884	$0	$0	$0	$19,884	0.028	$560
135	FY146	$19,884	$0	$0	$35,503	$55,387	0.027	$1,518
136	FY147	$19,884	$0	$0	$0	$19,884	0.027	$531
137	FY148	$19,884	$0	$0	$0	$19,884	0.026	$517
138	FY149	$19,884	$0	$0	$0 $19,	884	0.025	$503
139	FY150	$19,884	$0	$0	$0	$19,884	0.025	$490
140	FY151	$19,884	$0	$0	$35,503	$55,387	0.024	$1,329
141	FY152	$19,884	$0	$0	$0	$19,884	0.023	$465
142	FY153	$19,884	$0	$0	$0	$19,884	0.023	$452
143	FY154	$19,884	$0	$0	$0 $19,	884	0.022	$440
144	FY155	$19,884	$0	$0	$0	$19,884	0.022	$429

Table A3-4 Cost Estimate for Long-Term Monitoring, 208 year (remediation closeout) time period **cont.**

Year	Fiscal Year	Remedial Action and Monitoring Costs ($)	Monitoring Well Abandonment Costs ($)	O&M Costs ($)	5-Year Review Costs ($)	Total Costs ($)	Discount with R at 2.7%	Total Present Value Cost ($)
145	FY156	$19,884	$0	$0	$35,503	$55,387	0.021	$1,163
146	FY157	$19,884	$0	$0	$0	$19,884	0.020	$407
147	FY158	$19,884	$0	$0	$0	$19,884	0.020	$396
148	FY159	$19,884	$0	$0	$0 $19,	884	0.019	$386
149	FY160	$19,884	$0	$0	$0	$19,884	0.019	$375
150	FY161	$19,884	$0	$0	$35,503	$55,387	0.018	$1,018
151	FY162	$19,884	$0	$0	$0	$19,884	0.018	$356
152	FY163	$19,884	$0	$0	$0	$19,884	0.017	$347
153	FY164	$19,884	$0	$0	$0 $19,	884	0.017	$337
154	FY165	$19,884	$0	$0	$0	$19,884	0.017	$329
155	FY166	$19,884	$0	$0	$35,503	$55,387	0.016	$891
156	FY167	$19,884	$0	$0	$0	$19,884	0.016	$312
157	FY168	$19,884	$0	$0	$0	$19,884	0.015	$303
158	FY169	$19,884	$0	$0	$0 $19,	884	0.015	$295
159	FY170	$19,884	$0	$0	$0	$19,884	0.014	$288
160	FY171	$19,884	$0	$0	$35,503	$55,387	0.014	$780
161	FY172	$19,884	$0	$0	$0	$19,884	0.014	$273
162	FY173	$19,884	$0	$0	$0	$19,884	0.013	$266
163	FY174	$19,884	$0	$0	$0 $19,	884	0.013	$259
164	FY175	$19,884	$0	$0	$0	$19,884	0.013	$252
165	FY176	$19,884	$0	$0	$35,503	$55,387	0.012	$683
166	FY177	$19,884	$0	$0	$0	$19,884	0.012	$239
167	FY178	$19,884	$0	$0	$0	$19,884	0.012	$232
168	FY179	$19,884	$0	$0	$0 $19,	884	0.011	$226
169	FY180	$19,884	$0	$0	$0	$19,884	0.011	$220
170	FY181	$19,884	$0	$0	$35,503	$55,387	0.011	$598
171	FY182	$19,884	$0	$0	$0	$19,884	0.011	$209
172	FY183	$19,884	$0	$0	$0	$19,884	0.010	$203
173	FY184	$19,884	$0	$0	$0 $19,	884	0.010	$198
174	FY185	$19,884	$0	$0	$0	$19,884	0.010	$193
175	FY186	$19,884	$0	$0	$35,503	$55,387	0.009	$523
176	FY187	$19,884	$0	$0	$0	$19,884	0.009	$183
177	FY188	$19,884	$0	$0	$0	$19,884	0.009	$178
178	FY189	$19,884	$0	$0	$0 $19,	884	0.009	$173
179	FY190	$19,884	$0	$0	$0	$19,884	0.008	$169
180	FY191	$19,884	$0	$0	$35,503	$55,387	0.008	$458

Table A3-4 Cost Estimate for Long-Term Monitoring, 208 year (remediation closeout) time period **cont.**

Year	Fiscal Year	Remedial Action and Monitoring Costs ($)	Monitoring Well Abandonment Costs ($)	O&M Costs ($)	5-Year Review Costs ($)	Total Costs ($)	Discount with R at 2.7%	Total Present Value Cost ($)
181 FY	192	$19,884	$0	$0	$0	$19,884	0.008	$160
182 FY	193	$19,884	$0	$0	$0	$19,884	0.008	$156
183 FY	194	$19,884	$0	$0	$0 $19,	884	0.008	$152
184 FY	195	$19,884	$0	$0	$0	$19,884	0.007	$148
185 FY	196	$19,884	$0	$0	$35,503	$55,387	0.007	$401
186 FY	197	$19,884	$0	$0	$0	$19,884	0.007	$140
187 FY	198	$19,884	$0	$0	$0	$19,884	0.007	$136
188 FY	199	$19,884	$0	$0	$0 $19,	884	0.007	$133
189 FY	200	$19,884	$0	$0	$0	$19,884	0.007	$129
190 FY	201	$19,884	$0	$0	$35,503	$55,387	0.006	$351
191 FY	202	$19,884	$0	$0	$0	$19,884	0.006	$123
192 FY	203	$19,884	$0	$0	$0	$19,884	0.006	$119
193 FY	204	$19,884	$0	$0	$0 $19,	884	0.006	$116
194 FY	205	$19,884	$0	$0	$0	$19,884	0.006	$113
195 FY	206	$19,884	$0	$0	$35,503	$55,387	0.006	$307
196 FY	207	$19,884	$0	$0	$0	$19,884	0.005	$107
197 FY	208	$19,884	$0	$0	$0	$19,884	0.005	$105
198 FY	209	$19,884	$0	$0	$0 $19,	884	0.005	$102
199 FY	210	$19,884	$0	$0	$0	$19,884	0.005	$99
200 FY	211	$19,884	$0	$0	$35,503	$55,387	0.005	$269
201 FY	212	$19,884	$0	$0	$0	$19,884	0.005	$94
202 FY	213	$19,884	$0	$0	$0	$19,884	0.005	$91
203 FY	214	$19,884	$0	$0	$0 $19,	884	0.004	$89
204 FY	215	$19,884	$0	$0	$0	$19,884	0.004	$87
205 FY	216	$19,884	$0	$0	$35,503	$55,387	0.004	$235
206 FY	217	$19,884	$0	$0	$0	$19,884	0.004	$82
207 FY	218	$19,884	$0	$0	$0	$19,884	0.004	$80
208 FY	219	$19,884	$25,345	$0	$0 $45,	229	0.004	$177
Total		$4,396,603	$25,345	$0	$1,455,609	$5,877,557		$1,237,414

Table A3-5 Costs for EAB/MNA/LTM, 78 year (remediation closeout) time frame

Year	Fiscal Year	Remedial Action and Monitoring Costs($)	Monitoring Well Abandonment Costs($)	O&M Costs($)	5-Year Review Costs ($)	Total Costs ($)	Discount with R at 2.7%	Total Present Value Cost ($)
0	FY11	$1,738,548 $0		$0 $0		$1,738,548	1.000	$1,738,548
1	FY12	$158,195 $0		$1,495,204 $0		$1,653,399	0.974	$1,609,931
2	FY13	$67,353 $0		$1,495,204 $0		$1,562,557	0.948	$1,481,477
3	FY14	$67,353 $0		$1,495,204	$0 $1,	562,557	0.923	$1,442,529
4	FY15	$33,650	$0	$0 $0		$33,650	0.899	$30,248
5	FY16	$19,884	$0	$0 $38,	553	$58,437	0.875	$51,149
6	FY17	$19,884	$0	$0 $0		$19,884	0.852	$16,947
7	FY18	$19,884	$0	$0 $0		$19,884	0.830	$16,501
8	FY19	$19,884	$0	$0 $0		$19,884	0.808	$16,067
9	FY20	$19,884	$0	$0 $0		$19,884	0.787	$15,645
10	FY21	$19,884	$0	$0 $38,	553	$58,437	0.766	$44,770
11	FY22	$19,884	$0	$0 $0		$19,884	0.746	$14,833
12	FY23	$19,884	$0	$0 $0		$19,884	0.726	$14,443
13	FY24	$19,884	$0	$0 $0		$19,884	0.707	$14,063
14	FY25	$19,884	$0	$0 $0		$19,884	0.689	$13,694
15	FY26	$19,884	$0	$0 $38,	553	$58,437	0.671	$39,186
16	FY27	$19,884	$0	$0 $0		$19,884	0.653	$12,983
17	FY28	$19,884	$0	$0 $0		$19,884	0.636	$12,642
18	FY29	$19,884	$0	$0 $0		$19,884	0.619	$12,309
19	FY30	$19,884	$0	$0 $0		$19,884	0.603	$11,986
20	FY31	$19,884	$0	$0 $38,	553	$58,437	0.587	$34,299
21	FY32	$19,884	$0	$0 $0		$19,884	0.572	$11,364
22	FY33	$19,884	$0	$0 $0		$19,884	0.556	$11,065
23	FY34	$19,884	$0	$0 $0		$19,884	0.542	$10,774
24	FY35	$19,884	$0	$0 $0		$19,884	0.528	$10,491
25	FY36	$19,884	$0	$0 $38,	553	$58,437	0.514	$30,021
26	FY37	$19,884	$0	$0 $0		$19,884	0.500	$9,947
27	FY38	$19,884	$0	$0 $0		$19,884	0.487	$9,685
28	FY39	$19,884	$0	$0 $0		$19,884	0.474	$9,430
29	FY40	$19,884	$0	$0 $0		$19,884	0.462	$9,183
30	FY41	$19,884	$0	$0 $38,	553	$58,437	0.450	$26,277
31	FY42	$19,884	$0	$0 $0		$19,884	0.438	$8,706
32	FY43	$19,884	$0	$0 $0		$19,884	0.426	$8,477
33	FY44	$19,884	$0	$0 $0		$19,884	0.415	$8,254
34	FY45	$19,884	$0	$0 $0		$19,884	0.404	$8,037
35	FY46	$19,884	$0	$0 $38,	553	$58,437	0.394	$23,000

Table A3-5 Costs for EAB/MNA/LTM, 78 year (remediation closeout) time frame, **cont.**

Year	Fiscal Year	Remedial Action and Monitoring Costs($)	Monitoring Well Abandonment Costs($)	O&M Costs($)	5-Year Review Costs ($)	Total Costs ($)	Discount with R at 2.7%	Total Present Value Cost ($)
36	FY47	$19,884	$0	$0	$0	$19,884	0.383	$7,620
37	FY48	$19,884	$0	$0	$0	$19,884	0.373	$7,420
38	FY49	$19,884	$0	$0	$0	$19,884	0.363	$7,225
39	FY50	$19,884	$0	$0	$0	$19,884	0.354	$7,035
40	FY51	$19,884	$0	$0	$38,553	$58,437	0.344	$20,131
41	FY52	$19,884	$0	$0	$0	$19,884	0.335	$6,670
42	FY53	$19,884	$0	$0	$0	$19,884	0.327	$6,495
43	FY54	$19,884	$0	$0	$0	$19,884	0.318	$6,324
44	FY55	$19,884	$0	$0	$0	$19,884	0.310	$6,158
45	FY56	$19,884	$0	$0	$38,553	$58,437	0.302	$17,620
46	FY57	$19,884	$0	$0	$0	$19,884	0.294	$5,838
47	FY58	$19,884	$0	$0	$0	$19,884	0.286	$5,685
48	FY59	$19,884	$0	$0	$0	$19,884	0.278	$5,535
49	FY60	$19,884	$0	$0	$0	$19,884	0.271	$5,390
50	FY61	$19,884	$0	$0	$38,553	$58,437	0.264	$15,423
51	FY62	$19,884	$0	$0	$0	$19,884	0.257	$5,110
52	FY63	$19,884	$0	$0	$0	$19,884	0.250	$4,976
53	FY64	$19,884	$0	$0	$0	$19,884	0.244	$4,845
54	FY65	$19,884	$0	$0	$0	$19,884	0.237	$4,717
55	FY66	$19,884	$0	$0	$38,553	$58,437	0.231	$13,499
56	FY67	$19,884	$0	$0	$0	$19,884	0.225	$4,473
57	FY68	$19,884	$0	$0	$0	$19,884	0.219	$4,355
58	FY69	$19,884	$0	$0	$0	$19,884	0.213	$4,241
59	FY70	$19,884	$0	$0	$0	$19,884	0.208	$4,129
60	FY71	$19,884	$0	$0	$38,553	$58,437	0.202	$11,816
61	FY72	$19,884	$0	$0	$0	$19,884	0.197	$3,915
62	FY73	$19,884	$0	$0	$0	$19,884	0.192	$3,812
63	FY74	$19,884	$0	$0	$0	$19,884	0.187	$3,712
64	FY75	$19,884	$0	$0	$0	$19,884	0.182	$3,614
65	FY76	$19,884	$0	$0	$38,553	$58,437	0.177	$10,342
66	FY77	$19,884	$0	$0	$0	$19,884	0.172	$3,427
67	FY78	$19,884	$0	$0	$0	$19,884	0.168	$3,336
68	FY79	$19,884	$0	$0	$0	$19,884	0.163	$3,249
69	FY80	$19,884	$0	$0	$0	$19,884	0.159	$3,163
70	FY81	$19,884	$0	$0	$38,553	$58,437	0.155	$9,052
71	FY82	$19,884	$0	$0	$0	$19,884	0.151	$2,999

Table A3-5 Costs for EAB/MNA/LTM, 78 year (remediation closeout) time frame, **cont.**

Year	Fiscal Year	Remedial Action and Monitoring Costs($)	Monitoring Well Abandonment Costs($)	O&M Costs($)	5-Year Review Costs ($)	Total Costs ($)	Discount with R at 2.7%	Total Present Value Cost ($)
72 FY	83	$19,884	$0	$0 $0		$19,884	0.147	$2,920
73 FY	84	$19,884	$0	$0 $0		$19,884	0.143	$2,844
74 FY	85	$19,884	$0	$0 $0		$19,884	0.139	$2,769
75 FY	86	$19,884	$0	$0 $38,	553	$58,437	0.136	$7,923
76 FY	87	$19,884	$0	$0 $0		$19,884	0.132	$2,625
77 FY	88	$19,884	$0	$0 $0		$19,884	0.129	$2,556
78 FY	89	$19,884	$25,345	$0 $0		$45,229	0.125	$5,661
Total		$3,536,517	$25,345	$4,485,612	$578,295	$8,625,769		$7,109,607

Table A3-6 Cost Estimate for ISCO/LTM, 78 year (remediation closeout) time period								
Year	Fiscal Year	Remedial Action and Monitoring Costs($)	Monitoring Well Abandonment Costs($)	O&M Costs($)	5-Year Review Costs ($)	Total Costs ($)	Discount with R at 2.7%	Total Present Value Cost ($)
0 FY	11	$2,062,229 $0		$0 $0		$2,062,229	1.000	$2,062,229
1 FY	12	$158,195 $0		$1,522,131 $0	$1,	680,326	0.974	$1,636,150
2 FY	13	$33,650	$0	$1,522,131 $0	$1,	555,781	0.948	$1,475,053
3 FY	14	$33,650	$0	$1,522,131	$0 $1,	555,781	0.923	$1,436,273
4 FY	15	$33,650	$0	$0 $0		$33,650	0.899	$30,248
5 FY	16	$19,884	$0	$0 $38,	553	$58,437	0.875	$51,149
6 FY	17	$19,884	$0	$0 $0		$19,884	0.852	$16,947
7 FY	18	$19,884	$0	$0 $0		$19,884	0.830	$16,501
8 FY	19	$19,884	$0	$0 $0		$19,884	0.808	$16,067
9 FY	20	$19,884	$0	$0 $0		$19,884	0.787	$15,645
10 FY	21	$19,884	$0	$0 $38,	553	$58,437	0.766	$44,770
11 FY	22	$19,884	$0	$0 $0		$19,884	0.746	$14,833
12 FY	23	$19,884	$0	$0 $0		$19,884	0.726	$14,443
13 FY	24	$19,884	$0	$0 $0		$19,884	0.707	$14,063
14 FY	25	$19,884	$0	$0 $0		$19,884	0.689	$13,694
15 FY	26	$19,884	$0	$0 $38,	553	$58,437	0.671	$39,186
16 FY	27	$19,884	$0	$0 $0		$19,884	0.653	$12,983
17 FY	28	$19,884	$0	$0 $0		$19,884	0.636	$12,642
18 FY	29	$19,884	$0	$0 $0		$19,884	0.619	$12,309
19 FY	30	$19,884	$0	$0 $0		$19,884	0.603	$11,986
20 FY	31	$19,884	$0	$0 $38,	553	$58,437	0.587	$34,299
21 FY	32	$19,884	$0	$0 $0		$19,884	0.572	$11,364
22 FY	33	$19,884	$0	$0 $0		$19,884	0.556	$11,065
23 FY	34	$19,884	$0	$0 $0		$19,884	0.542	$10,774
24 FY	35	$19,884	$0	$0 $0		$19,884	0.528	$10,491
25 FY	36	$19,884	$0	$0 $38,	553	$58,437	0.514	$30,021
26 FY	37	$19,884	$0	$0 $0		$19,884	0.500	$9,947
27 FY	38	$19,884	$0	$0 $0		$19,884	0.487	$9,685
28 FY	39	$19,884	$0	$0 $0		$19,884	0.474	$9,430
29 FY	40	$19,884	$0	$0 $0		$19,884	0.462	$9,183
30 FY	41	$19,884	$0	$0 $38,	553	$58,437	0.450	$26,277
31 FY	42	$19,884	$0	$0 $0		$19,884	0.438	$8,706
32 FY	43	$19,884	$0	$0 $0		$19,884	0.426	$8,477
33 FY	44	$19,884	$0	$0 $0		$19,884	0.415	$8,254
34 FY	45	$19,884	$0	$0 $0		$19,884	0.404	$8,037

Table A3-6 Cost Estimate for ISCO/LTM, 78 year (remediation closeout) time period, **cont.**

Year	Fiscal Year	Remedial Action and Monitoring Costs($)	Monitoring Well Abandonment Costs($)	O&M Costs($)	5-Year Review Costs ($)	Total Costs ($)	Discount with R at 2.7%	Total Present Value Cost ($)
35 FY	46	$19,884	$0	$0 $38,	553	$58,437	0.394	$23,000
36 FY	47	$19,884	$0	$0 $0		$19,884	0.383	$7,620
37 FY	48	$19,884	$0	$0 $0		$19,884	0.373	$7,420
38 FY	49	$19,884	$0	$0 $0		$19,884	0.363	$7,225
39 FY	50	$19,884	$0	$0 $0		$19,884	0.354	$7,035
40 FY	51	$19,884	$0	$0 $38,	553	$58,437	0.344	$20,131
41 FY	52	$19,884	$0	$0 $0		$19,884	0.335	$6,670
42 FY	53	$19,884	$0	$0 $0		$19,884	0.327	$6,495
43 FY	54	$19,884	$0	$0 $0		$19,884	0.318	$6,324
44 FY	55	$19,884	$0	$0 $0		$19,884	0.310	$6,158
45 FY	56	$19,884	$0	$0 $38,	553	$58,437	0.302	$17,620
46 FY	57	$19,884	$0	$0 $0		$19,884	0.294	$5,838
47 FY	58	$19,884	$0	$0 $0		$19,884	0.286	$5,685
48 FY	59	$19,884	$0	$0 $0		$19,884	0.278	$5,535
49 FY	60	$19,884	$0	$0 $0		$19,884	0.271	$5,390
50 FY	61	$19,884	$0	$0 $38,	553	$58,437	0.264	$15,423
51 FY	62	$19,884	$0	$0 $0		$19,884	0.257	$5,110
52 FY	63	$19,884	$0	$0 $0		$19,884	0.250	$4,976
53 FY	64	$19,884	$0	$0 $0		$19,884	0.244	$4,845
54 FY	65	$19,884	$0	$0 $0		$19,884	0.237	$4,717
55 FY	66	$19,884	$0	$0 $38,	553	$58,437	0.231	$13,499
56 FY	67	$19,884	$0	$0 $0		$19,884	0.225	$4,473
57 FY	68	$19,884	$0	$0 $0		$19,884	0.219	$4,355
58 FY	69	$19,884	$0	$0 $0		$19,884	0.213	$4,241
59 FY	70	$19,884	$0	$0 $0		$19,884	0.208	$4,129
60 FY	71	$19,884	$0	$0 $38,	553	$58,437	0.202	$11,816
61 FY	72	$19,884	$0	$0 $0		$19,884	0.197	$3,915
62 FY	73	$19,884	$0	$0 $0		$19,884	0.192	$3,812
63 FY	74	$19,884	$0	$0 $0		$19,884	0.187	$3,712
64 FY	75	$19,884	$0	$0 $0		$19,884	0.182	$3,614
65 FY	76	$19,884	$0	$0 $38,	553	$58,437	0.177	$10,342
66 FY	77	$19,884	$0	$0 $0		$19,884	0.172	$3,427
67 FY	78	$19,884	$0	$0 $0		$19,884	0.168	$3,336
68 FY	79	$19,884	$0	$0 $0		$19,884	0.163	$3,249
69 FY	80	$19,884	$0	$0 $0		$19,884	0.159	$3,163

Table A3-6 Cost Estimate for ISCO/LTM, 78 year (remediation closeout) time period, **cont.**

Year	Fiscal Year	Remedial Action and Monitoring Costs($)	Monitoring Well Abandonment Costs($)	O&M Costs($)	5-Year Review Costs ($)	Total Costs ($)	Discount with R at 2.7%	Total Present Value Cost ($)
70 FY	81	$19,884	$0	$0 $38,	553	$58,437	0.155	$9,052
71 FY	82	$19,884	$0	$0 $0		$19,884	0.151	$2,999
72 FY	83	$19,884	$0	$0 $0		$19,884	0.147	$2,920
73 FY	84	$19,884	$0	$0 $0		$19,884	0.143	$2,844
74 FY	85	$19,884	$0	$0 $0		$19,884	0.139	$2,769
75 FY	86	$19,884	$0	$0 $38,	553	$58,437	0.136	$7,923
76 FY	87	$19,884	$0	$0 $0		$19,884	0.132	$2,625
77 FY	88	$19,884	$0	$0 $0		$19,884	0.129	$2,556
78 FY	89	$19,884	$25,345	$0 $0		$45,229	0.125	$5,661
Total	$3,	792,792	$25,345	$4,566,393	$578,295	$8,962,825		$7,446,828