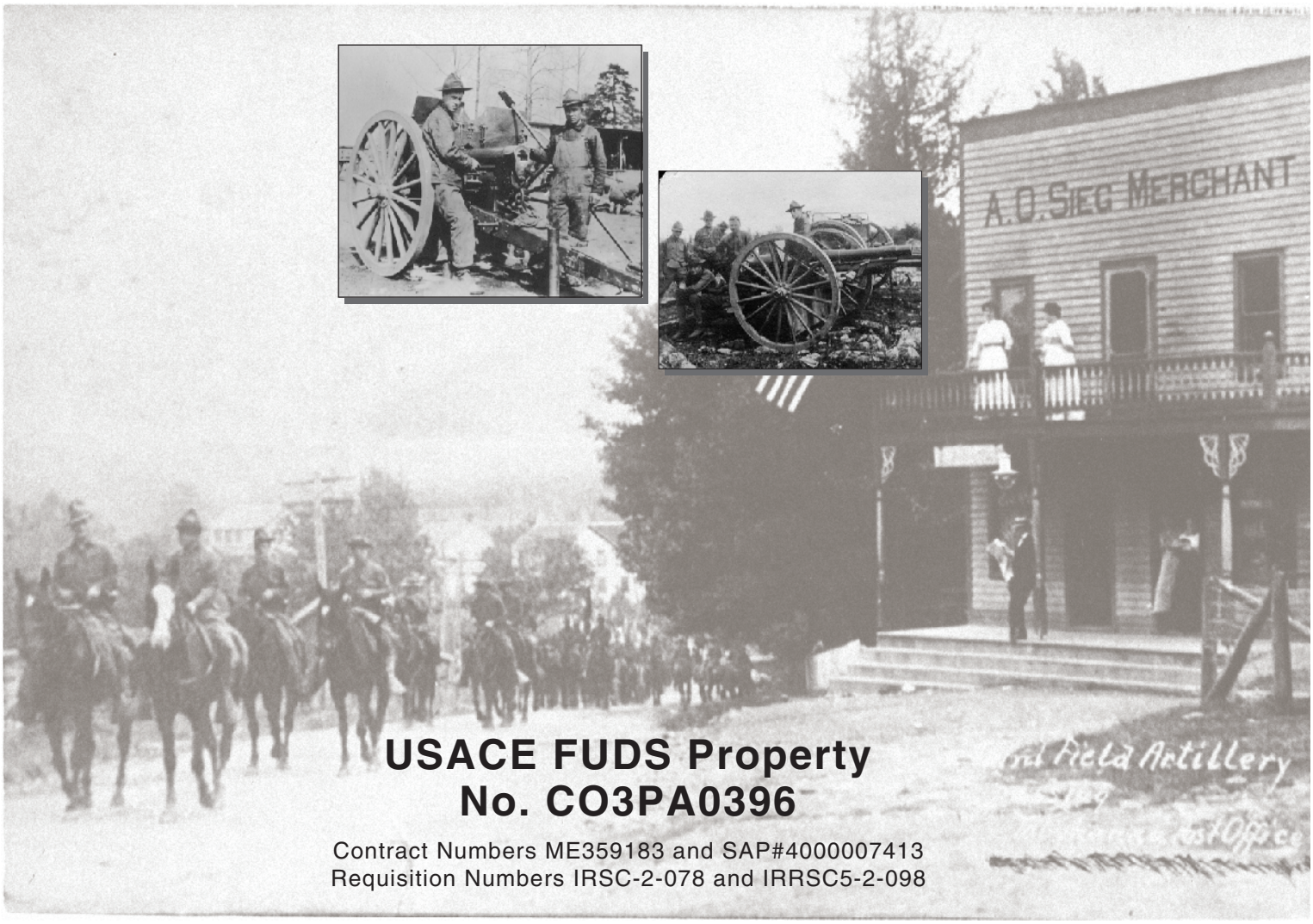
Final
Feasibility Study

Tobyhanna Artillery Range Formerly Used Defense Site
Tobyhanna, Pennsylvania



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Prepared For:

Pennsylvania Department of
Environmental Protection
Northeast Regional Office
2 Public Square
Wilkes-Barre, Pennsylvania 18711

Baltimore District
US Army Corps of Engineers
10 South Howard Street
Baltimore, Maryland 21201-1715

Prepared By:

Weston Solutions, Inc.
1400 Weston Way
West Chester, Pennsylvania 19380

05P-0909

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USACE FUDS Property No. CO3PA0396

WESTON – Project Engineer
Matthew E. Clapp, P.E.

22 July 05
Date

WESTON – Project Manager
Gregory S. Daloisio

22 July 05
Date

WESTON – UXO Director
Charles H. Heaton, Jr., P.E.

18 Jul 05
Date

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LIST OF ACRONYMS AND ABBREVIATIONS

A-A	anti-aircraft
AOC	area of concern
AR	Army regulation
AOI	area of interest
ARAR	applicable or relevant and appropriate
ASR	Archives Search Report
AT	anti-tank
ATSDR	Agency for Toxic Substances and Disease Registry
AWQC	ambient water quality criteria
bgs	below ground surface
BIP	blow-in-place
BZ	buffer zone
CEHNC	U.S. Army Corps of Engineers, Huntsville Engineering and Support Center
CENAB	U.S. Army Corps of Engineers, Baltimore District
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERFA	Community Environmental Response Facilitation Act
CFR	Code of Federal Regulations
cm	centimeter
CSM	conceptual site model
DCNR	Pennsylvania Department of Conservation and Natural Resources
DERP	Defense Environmental Restoration Program
^{o}F	degrees Fahrenheit
DGM	digital geophysical mapping
DGPS	differential global positioning system
DID	Data Item Description
DMM	discarded military munitions
DOD	U.S. Department of Defense
DOI	U.S. Department of Interior
DOT	U.S. Department of Transportation

LIST OF ACRONYMS AND ABBREVIATIONS (CONTINUED)

DQCR	Daily Quality Control Report
DQO	data quality objective
DTL	Design Team Leader
EA	environmental assessment
EE/CA	engineering evaluation and cost analysis
EHS	extremely hazardous substances
EIS	environmental impact statement
EM	electromagnetic
EO	Executive Order
EOD	explosive ordnance disposal
EOR	explosive ordnance reconnaissance
EPA	U. S. Environmental Protection Agency
EPIC	Environmental Photographic Interpretation Center (EPA)
EPP	Environmental Protection Plan
ERA	ecological risk assessment
ER-L	effects range-low
ESOH	Environment, Safety, and Occupational Health
ESRI	Environmental Systems Research Institute
FP	firing point
FS	feasibility study
ft	feet
FUDS	Formerly Used Defense Site
GIS	geographic information system
GM	geometric mean
GPO	geophysical prove-out
GPS	global positioning system
GSD	geometric standard deviation
HE	high explosives
HFA	Human Factors Applications, Inc.
H&S	health and safety
HTW	hazardous or toxic waste

LIST OF ACRONYMS AND ABBREVIATIONS (CONTINUED)

HTRW	hazardous, toxic or radiological wastes
IA	impact area
IAR	instrument-aided reconnaissance
LS	lump sum
LUC	land use controls
m	meter
MAG	magnetometric
MC	munitions constituents
MD	munitions debris
M&D	mag and dig
MEC	munitions and explosives of concern
MGFD	munition with the greatest fragmentation distance
MHE	materials handling equipment
mm	millimeter
MMR	Military Munition Response
MMRP	Military Munitions Response Program
MOU	memorandum of understanding
MPM	most probable munition
mph	miles per hour
MPPEH	materials potentially presenting an explosive hazard
MR	munitions response
MS	Microsoft®
MSD	minimum separation distance
NCP	National Oil and Hazardous Substance Pollution Contingency Plan
NE	Northeast
NIH	National Institute of Health
OE	ordnance and explosives (OE is replaced by MEC in this report)
OE MCX	Ordnance and Explosives Mandatory Center of Expertise
OERIA	Ordnance and Explosive Risk Impact Assessment
OESS	Ordnance and Explosives Safety Specialist
OEW	ordnance and explosive waste

LIST OF ACRONYMS AND ABBREVIATIONS (CONTINUED)

OSHA	Occupational Safety and Health Administration
OSWER	Office of Solid Waste and Emergency Response
OU	operable unit
PA	preliminary assessment
PADEP	Pennsylvania Department of Environmental Protection
PC	personal computer
PCB	polychlorinated biphenyl
PCE	Project Controls Engineer
PDA	Personal Digital Assistant
PGC	Pennsylvania Game Commission
PHA	public health assessment
PM	Project Manager
PPE	Personal protective equipment
POC	Point-of-Contact
QA	Quality Assurance
QC	Quality Control
RAC	Risk Assessment Code (USACE)
RAO	remedial action objective
RBC	risk-based concentration
RF	range safety fan
RI	remedial investigation
ROD	Record of Decision
RSP	Render safe procedures
SAP	Sampling and Analysis Plan
SI	site inspection
SLC	screening level concentration
SLERA	screening level ecological risk assessment
SLRA	screening level risk assessment
SOW	scope of work
SQL	sample quantitation limit
SSHP	Site Safety and Health Plan

LIST OF ACRONYMS AND ABBREVIATIONS (CONTINUED)

SSTT	Spiked-Sediment Toxicity Test
SW	Southwest
SW/SD	surface water/sediment
TA	target area
TBC	to be considered criteria
TCL	Target Compound List
TCRA	Time Critical Removal Action
THQ	target hazard quotient
TL	Team Leader
TOAR	Tobyhanna Artillery Ranges
TPP	Technical Project Planning
TYAD	Tobyhanna Army Depot
U.S.C.	United States Code
UPS	uninterruptible power supply
USACE	U.S. Army Corps of Engineers
U.S.ft	U.S. Survey Feet
USFWS	U. S. Fish and Wildlife Service
USRADS	Ultrasonic Ranging Data System
UTM	Universal Transverse Mercator
UXO	unexploded ordnance
UXOQCS	UXO Quality Control Specialist
UXOSO	UXO Safety Officer
WESTON	Weston Solutions, Inc.
WWII	World War II

EXECUTIVE SUMMARY

The Pennsylvania Department of Environmental Protection (PADEP) is conducting a remedial investigation/feasibility study (RI/FS) at the Tobyhanna Artillery Range Formerly Used Defense Site (TOAR-FUDS) located in Tobyhanna, Pennsylvania to address munitions and explosives of concern (MEC) present at the site. The RI and FS reports for the TOAR-FUDS are being prepared and submitted as separate documents. This report represents the FS report. The RI report was submitted as a standalone document (WESTON, 2005b).

The majority of the TOAR-FUDS is located in Monroe County, with a small portion of the northeast quadrant of the site falling within Wayne County, in northeastern Pennsylvania. The TOAR-FUDS consists of two adjacent land areas owned by the Commonwealth of Pennsylvania and divided by I-380. The northeastern portion is managed by the Pennsylvania Department of Conservation and Natural Resources (DCNR) and is comprised of portions of Tobyhanna State Park (Park). The southwestern portion is managed by the Pennsylvania Game Commission and is comprised of portions of the Pennsylvania State Game Lands Number 127 (Game).

Limited removal actions have been performed in some areas at the site in the past, but there have been no other investigations conducted at the site prior to the RI conducted by WESTON in 2004. Results of the RI are presented in the RI report (WESTON, 2005b). The data collected during the field investigation and the conclusions drawn in the RI were used when developing this FS.

The RI report identified nine (9) areas of concern (AOCs) at the TOAR-FUDS. AOCs TOAR-1, TOAR-2, TOAR-3, TOAR-4, and TOAR-5 have high risk associated with MEC, and AOCs TOAR-6, TOAR-7, TOAR-8, and TOAR-9 have low or low-moderate risk associated with MEC. The term MEC distinguishes specific categories of military munitions that may pose unique explosive safety risks, including the following:

- Unexploded ordnance (UXO) – Military munitions that fulfill the following criteria:
  - Have been primed, fuzed, armed, or otherwise prepared for action;

  - Have been fired, dropped, launched, projected, or placed in such a manner as to constitute a hazard to operations, installations, personnel, or material; and
  - Remain unexploded either by malfunction, design, or any other cause (United States Code [U.S.C.] §2710 (e) (9)).

- Discarded military munitions (DMM) – Military munitions that have been abandoned without proper disposal or removed from storage in a military magazine or other storage area for the purpose of disposal. The term does not include UXO, military munitions that are being held for future use or planned disposal, or military munitions that have been properly disposed of consistent with applicable environmental laws and regulations. (10 U.S.C. §2710 (e) (2)).
- Munitions constituents such as TNT and RDX present in high enough concentrations to pose an explosive hazard (U.S. Army, 2005).

The nature and extent of MEC was investigated by sampling for UXO, DMM and Munitions Constituents (MC), which are any materials originating from UXO, discarded military munitions, or other military munitions, including explosive and non explosive materials, and emission, degradation, or breakdown elements of such ordnance or munitions (10 U.S.C. §2710 (e)(4)).

No DMM have been recovered at the TOAR-FUDS, and no munitions constituents such as TNT and RDX have been found in high enough concentrations to pose an explosive hazard. All MEC recovered at the site to date have been classified as UXO. In addition, metals and explosives concentrations in soil, sediment, and surface water present no unacceptable risk to human health and the environment. Therefore, the purpose of this FS is to identify, develop, and perform a detailed analysis of potential remedial alternatives that would meet the remedial action objectives (RAOs) for UXO, so that the decision-makers will have adequate information to select the most appropriate remedial alternative(s) for the TOAR-FUDS. The selected alternatives are expected to mitigate, reduce, or eliminate unacceptable risks to human health and the environment from UXO, based on future use of the property.

The following major steps were involved in the development of this FS:

- Identification of RAOs.
- Identification of Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered criteria (TBCs).
- Identification of general remedial actions.

- Identification and screening of potentially applicable remedial technologies and process options for the general response actions.
- Development and screening of a range of remedial alternatives for the site based on combinations of the remedial technologies that were retained.
- Performance of a detailed analysis for each of the remedial alternatives using the evaluation criteria required by the National Oil and Hazardous Substances Pollution Contingency Plan (NCP).
- Identification of the most appropriate/viable remedial alternative(s) that meet the RAOs.

The goal of a remedial action is to reduce explosives safety hazards or contaminants of concern to ensure protection of human health, public safety, and the environment. To achieve this goal at the TOAR-FUDS, the appropriateness and effectiveness of potential remedial actions in the nine (9) AOCs for minimizing the public's exposure to UXO while maintaining the current and intended future land use of public access for recreational activities were evaluated in this FS.

The RAOs established for the TOAR-FUDS guided the development of alternatives for each AOC and focused the comparison of acceptable remedial action alternatives, as warranted. These objectives also assisted in clarifying the goal of minimizing the explosive risk and achieving an acceptable level of protection for human health and the environment. These objectives included:

- Reduce or eliminate potential UXO exposure pathways.
- Meet NCP criteria.

Three categories of applicable or relevant and appropriate requirements (ARARs) were evaluated for the TOAR-FUDS, along with to be considered criteria (TBCs). The ARAR categories are: chemical-specific, location-specific, and action-specific.

General remedial actions are those actions that will be evaluated to achieve the RAOs. General remedial actions that were considered for the TOAR-FUDS include No Action, Land Use Controls (LUCs), and UXO removal activities. UXO removal activities include technologies used for detection, positioning, removal, disposal, and waste stream treatment (if necessary). The various technologies currently available for UXO removal activities were screened for effectiveness, implementability, and cost to assess the viability of each technology at the TOAR-FUDS and to provide additional information to future decision makers.

The general remedial actions identified above were converted into remedial alternatives for analysis and comparison for the TOAR-FUDS as follows:

1. No Action – Required to be evaluated by the NCP.
2. Land Use Controls (LUCs).
3. Surface removal of UXO – Removal of UXO detected on the ground surface and breaching the ground surface.
4. Removal of UXO to one foot – Removal of UXO detected on the ground surface and removal of UXO with any part within one foot of the ground surface.
5. Removal of UXO to detection depth – Removal of all UXO detected. Depth of detection varies based on depth of UXO at the site and detection technology used.

Remedial alternatives deemed highly viable for use at the TOAR-FUDS were assessed in a detailed evaluation against the evaluation criteria described in the NCP, Section 300.430. The evaluation criteria are as follows:

1. Overall protectiveness of human health and the environment.
2. Compliance with ARARs and TBCs.
3. Long-term effectiveness and permanence.
4. Reduction of toxicity, mobility, or volume (TMV) of contaminants through treatment.
5. Short-term effectiveness.
6. Implementability.
7. Cost.
8. Regulatory agency acceptance.

Regulatory agency acceptance is usually evaluated following comment on the FS. However, regulatory agency acceptance is addressed preliminarily in this FS based on input received from PADEP and EPA throughout the project. Also, community acceptance is another criterion defined in the NCP that considers whether the local community agrees with the Army's analyses and preferred alternative. Community acceptance is also usually evaluated following comment on the FS, and is not addressed in this FS. Community acceptance will be evaluated following comment on the FS, and completed after the Proposed Plan and public comment period on that Plan in the Decision Document.

Remedial alternatives for AOCs with the same risk were combined in this FS to minimize redundancy in the detailed analysis. Therefore, remedial alternatives for AOCs with high risk (TOAR-1, TOAR-2, TOAR-3, TOAR-4, and TOAR-5) were analyzed together, and remedial alternatives for AOCs with low or low-moderate risk (TOAR-6, TOAR-7, TOAR-8 and TOAR-9) were analyzed together. Based on the detailed analysis of remedial alternatives, the strengths and weaknesses of the remedial alternatives relative to one another were evaluated with respect to each of the NCP criteria, as shown in Tables ES-1 and ES-2. In each table, the alternatives are evaluated qualitatively, then ranked from best to worst and given a corresponding score of 1 to 2 (for AOCs with low or low-moderate risk) or 1 to 5 (for AOCs with high risk) for each criterion. The scores for each alternative are then totaled in order to develop a relative ranking of alternatives for all AOCs.

This approach to analyzing alternatives is designed to provide decision makers with sufficient information to adequately compare the alternatives, select an appropriate remedy for each AOC, and demonstrate satisfaction of the CERCLA remedy selection requirements in the Decision Document.

Table ES-1 Comparative Analysis of Remedial Alternatives for AOCs with Low or Low-Moderate Risk

Alternative	Overall Protectiveness of Human Health and the Environment	Compliance with ARARs and TBCs	Long-Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, or Volume (TMV) of Contaminants Through Treatment	Short-Term Effectiveness	Implementability	Cost	Regulatory Agency Acceptance[1]	Score	Rank
1 No Action	HH: Not protective EN: Not protective 2[2]	Not compliant 2	EFF: Not effective PER: Not permanent 2	No reduction 1.5	Not effective 2	Extremely implementable 1	1	No acceptance 2	13.5	**2**
2 LUC	HH: Minimally protective EN: Protective 1	Minimally compliant 1	EFF: Minimally effective PER: Potentially permanent 1	No reduction 1.5	Extremely effective 1	Very implementable 2	2	Acceptance 1	10.5	**1**

HH = Human health; EN = Environment; EFF = Effectiveness; PER = Permanence.

[1]Regulatory agency acceptance is usually evaluated following comment on the FS. However, regulatory agency acceptance is addressed preliminarily in this FS based on input received from PADEP and EPA throughout the project.

[2]Scores indicate the relative ranking of alternatives under each criteria, with 1 = best alternative for that criteria, and 2 = worst alternative for that criteria. Alternatives with the same relative ranking under a specific criterion receive a score of 1.5. The scores are then totaled, and the alternative with the lowest score receives a relative ranking of 1.

Table ES-2 Comparative Analysis of Remedial Alternatives for AOCs with High Risk

Alternative	Overall Protectiveness of Human Health and the Environment	Compliance with ARARs and TBCs	Long-Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, or Volume (TMV) of Contaminants Through Treatment	Short-Term Effectiveness	Implementability	Cost	Regulatory Agency Acceptance[1]	Score	Rank
1 No Action	HH: Not protective EN: Protective 5[2]	Not compliant 5	EFF: Not effective PER: Not permanent 5	No reduction 4.5	Not effective 5	Most implementable 1	1	Not acceptable 5	31.5	**5**
2 LUC	HH: Minimally protective EN: Protective 4	Minimally compliant 4	EFF: Minimally effective PER: Potentially permanent 4	No reduction 4.5	Most effective 1	More implementable 2	2	Minimally acceptable 4	25.5	**4**
3 Surface Removal of UXO with LUCs	HH: Protective EN: Disruptive 3	Compliant 3	EFF: Effective PER: Permanent 3	Approximately 80% reduction 3	More effective 2	Implementable 4	3	Acceptable 3	24	**3**
4 Removal of UXO to One Foot with LUCs	HH: More protective EN: More disruptive 1.5	More compliant 2	EFF: More effective PER: More permanent 2	Approximately 95% reduction 2	Effective 3	Implementable 4	4	More acceptable 2	20.5	**2**
5 Removal of UXO to Detection Depth with LUCs	HH: Most protective EN: Most disruptive 1.5	Most compliant 1	EFF: Most effective PER: Most permanent 1	Approximately 100% reduction 1	Minimally effective 4	Implementable 4	5	Most acceptable 1	18.5	**1**

HH = Human health; EN = Environment; EFF = Effectiveness; PER = Permanence.

[1]Regulatory agency acceptance is usually evaluated following comment on the FS. However, regulatory agency acceptance is addressed preliminarily in this FS based on input received from PADEP and EPA throughout the project.

[2]Scores indicate the relative ranking of alternatives under each criteria, with 1 = best alternative for that criteria, and 5 = worst alternative for that criteria. Alternatives with the same relative ranking under a specific criterion receive the average of successive scores (i.e. two alternatives tied for second would get a rating of [2+3]/2 = 2.5). The scores are then totaled, and the alternative with the lowest score receives a relative ranking of 1.

1. INTRODUCTION

The Pennsylvania Department of Environmental Protection (PADEP) has contracted Weston Solutions, Inc. (WESTON) to perform a Feasibility Study (FS) for the Tobyhanna Artillery Range Formerly Used Defense Site (TOAR-FUDS), Tobyhanna, Pennsylvania. The TOAR-FUDS is one of the sites included in the Defense Environmental Restoration Program - Formerly Used Defense Sites (DERP-FUDS). This FS has been developed under the FUDS program to address munitions and explosives of concern (MEC) present at the site. All MEC recovered at the site to date have been classified as unexploded ordnance (UXO).

This FS has been prepared in compliance with the U.S. Environmental Protection Agency (EPA) document *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA*, October 1988, and the U.S Army Corps of Engineers (USACE) *Engineering Pamphlet 1110-1-18, Ordnance and Explosives Response*, under PADEP Contract ME3519183, Project Number ISRC-2-078. The funding for the FS is provided by PADEP, and technical support and oversight to PADEP is provided by the U.S. Army Corps of Engineers, Baltimore District (CENAB).

1.1 PURPOSE

The purpose of this FS is to identify, develop, and perform a detailed analysis of potential remedial alternatives that would meet the remedial action objectives (RAOs), so that the decision-makers will have adequate information to select the most appropriate remedial alternative(s) for the TOAR-FUDS. The selected alternatives are expected to mitigate, reduce, or eliminate unacceptable risks to human health and the environment from UXO, based on current and intended future use of the property.

The following major steps are involved in the development of the FS:

- Identification of RAOs (subsection 1.4).
- Identification of Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered criteria (TBCs) (Section 2).
- Identification of general remedial actions (Section 3).

- Identification and screening of potentially applicable remedial technologies and process options for the general response actions (Section 3).
- Development and screening of a range of remedial alternatives for the site based on combinations of the remedial technologies that were retained (Section 4).
- Performance of a detailed analysis for each of the remedial alternatives using the evaluation criteria as required by the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (Section 5).
- Identification of the most appropriate/viable remedial alternative(s) that meet the RAOs (Section 5).

Comments received and responses made for this FS are provided in Appendix A.

1.2 PROJECT BACKGROUND

The majority of the TOAR-FUDS is located in Monroe County, with a small portion of the northeast quadrant of the site falling within Wayne County, in northeastern Pennsylvania. The TOAR-FUDS consists of two adjacent land areas owned by the Commonwealth of Pennsylvania and divided by I-380. The northeastern portion is managed by the Pennsylvania Department of Conservation and Natural Resources (DCNR) and is comprised of portions of Tobyhanna State Park (Park). The southwestern portion is managed by the Pennsylvania Game Commission (PGC) and is comprised of portions of the Pennsylvania State Game Lands Number 127 (Game).

The TOAR-FUDS was composed of approximately 21,100 acres. The Army originally leased the lands of the TOAR-FUDS in 1912 for the purpose of troop training. Later that year the Army formally acquired the lands. Both regular Army and National Guard field artillery units from throughout the Northeast and Mid-Atlantic states trained at Tobyhanna. During World War I, the reservation also served as a training center for tank and ambulance units. Prior to World War II, training was expanded to include cadets from the Army's Military Academy at West Point. Training reached its height during World War II with intensive artillery training being conducted. After the end of World War II, both the mission and activities of the artillery ranges were phased out.

In 1949, 14,000 acres were deeded to the Commonwealth of Pennsylvania's Game Commission. This land formed the basis for State Game Lands Number 127 (Game). Also in 1949, an

additional 7,080 acres were deeded to the Commonwealth of Pennsylvania's Department of Forest and Waters. This land formed the basis for the Tobyhanna State Park and Gouldsboro State Park (Park).

On 1 October 1952, the Commonwealth of Pennsylvania sold 1,418.49 acres of the area back to the U.S. Government. This tract of the original TOAR was required for the establishment and development of the Tobyhanna Signal Depot, which was officially commissioned on 1 February 1953 and remains active today, having been renamed the Tobyhanna Army Depot (TYAD).

Today, the Park covers the northeastern third of the site, currently contains minimal infrastructure, and is used for multiple recreational purposes, including camping, boating, swimming, hunting, fishing, hiking, snowmobiling, and mountain biking. Game covers the remaining southwestern portion of the site and serves as a habitat for large and small game animals that are hunted in season, and features several lakes and streams that are fished regularly. The PGC uses some of the land in Game for food plots, and has designated much of the land in Game for future timber sales.

The TOAR-FUDS falls under the DERP-FUDS Program; however, due to funding constraints, USACE was unable to execute the project at this time. To aid the process and speed the protection of the public and site workers, PADEP has agreed to both contract and fund the remedial investigation/feasibility study (RI/FS) phase of the Munitions Response (MR). CENAB has agreed to support PADEP with MEC technical expertise in the execution of the project. To facilitate this support, PADEP and CENAB have entered into a Memorandum of Understanding (MOU) (PADEP, 2003) that describes each agency's, roles, responsibilities, and authorities. PADEP, with concurrence from CENAB, selected WESTON of West Chester, Pennsylvania to serve as the contractor for this project.

The project was originally scoped with the objective to conduct adequate field investigations to allow the preparation and approval of an Engineering Evaluation and Cost Analysis (EE/CA) for the project site. This work focused primarily on the safety hazards associated with MEC contamination as part of a removal response action. In May 2004, the Department of the Army published ER 200-3-1, Formerly Used Defense Sites (FUDS) Program Policy. This policy requires that all response activities undertaken by USACE that address Military Munitions

Response Program (MMRP) sites as part of the FUDS program be conducted in accordance with CERCLA, Executive Order (EO) 12580, Superfund Implementation (January 23, 1986); EO 13016, Superfund Amendments (August 28, 1996); and the NCP (40 Code of Federal Regulations [CFR] Part 300).

The ultimate objective under CERCLA is to protect human health, welfare, and the environment from hazards associated with both MEC and munitions constituents (MC) from MMRP sites. Consequently, the scope of the project was transitioned from an EE/CA to an RI/FS to meet the substantive requirements of ER 200-3-1. A remedial investigation (RI) was conducted by WESTON in 2004 at the TOAR-FUDS (WESTON, 2005b). In addition to MEC hazards, potential contamination from MC at the site was evaluated during the RI relative to impacts to both human health and the environment (i.e., ecological impacts). Because MC sampling had not been previously conducted at the TOAR-FUDS, MC sampling was conducted at a site inspection (SI) level based on biased high sampling locations to determine if contaminant levels warranted further investigation.

The data collected during the field investigation, and the conclusions drawn in the RI were used when developing this FS. The RI identified nine (9) areas of concern (AOCs) at the TOAR-FUDS. AOCs TOAR-1, TOAR-2, TOAR-3, TOAR-4, and TOAR-5 have high risk associated with MEC, and AOCs TOAR-6, TOAR-7, TOAR-8, and TOAR-9 have low risk associated with MEC. Limited removal actions have been performed at some of AOCs in the past. There have been no other investigations conducted at the site prior to the 2004 RI.

1.3 SUMMARY OF REMEDIAL INVESTIGATION RESULTS

This section provides a summary of the results of the RI conducted at the TOAR-FUDS, including the nature and extent of MEC, and the risk associated with MEC. The results of the RI are discussed in greater detail in the RI report for the TOAR-FUDS (WESTON, 2005b), which was published as a separate document.

The term MEC distinguishes specific categories of military munitions that may pose unique explosive safety risks, including the following:

- Unexploded ordnance (UXO) – Military munitions that fulfill the following criteria:
  - Have been primed, fuzed, armed, or otherwise prepared for action;
  - Have been fired, dropped, launched, projected, or placed in such a manner as to constitute a hazard to operations, installations, personnel, or material; and
  - Remain unexploded either by malfunction, design, or any other cause (United States Code [U.S.C.] §2710 (e) (9)).
- Discarded military munitions (DMM) – Military munitions that have been abandoned without proper disposal or removed from storage in a military magazine or other storage area for the purpose of disposal. The term does not include UXO, military munitions that are being held for future use or planned disposal, or military munitions that have been properly disposed of consistent with applicable environmental laws and regulations. (10 U.S.C. §2710 (e) (2)).
- Munitions constituents such as TNT and RDX present in high enough concentrations to pose an explosive hazard (U.S. Army, 2005).

The nature and extent of MEC was investigated by sampling for UXO, DMM and Munitions Constituents (MC), which are any materials originating from UXO, discarded military munitions, or other military munitions, including explosive and non explosive materials, and emission, degradation, or breakdown elements of such ordnance or munitions (10 U.S.C. §2710 (e)(4)).

1.3.1 Munitions and Explosives of Concern

A combination of digital and analog investigative methods was performed at the TOAR-FUDS to characterize the nature and extent of MEC at the site, to validate and refine the conceptual site model (CSM), and to support risk-based selection of MEC remedial alternatives. Using the data from all sources, the site was characterized with a high degree of certainty for MEC contamination. The sources of data, or lines of evidence, used to characterize the site include the following:

1. Historical information.
   a. Archives Search Report (ASR) (EPA, 2003a).
   b. EPA Environmental Photographic Interpretation Center (EPIC) Study (USACE, 1995).
   c. Historical maps.

2. UXO recovered during all previous work at the TOAR-FUDS and munitions debris (MD) recovered during WESTON activities at the TOAR-FUDS.
    a. 1998 HFA Time-Critical Removal Action (TCRA) – Park.
    b. 1998 HFA Construction Support – TYAD.
    c. 2004 WESTON Construction Support – TYAD.
    d. 2004 WESTON TCRA – Game.
    e. 2004 WESTON site visits.
    f. 2004 CENAB site visits.
    g. 2004 WESTON RI.
3. Artillery range layouts.
    a. Historical layouts (USACE provided).
    b. Current range layout standards.
4. Visual evidence.
    a. Targets.
    b. Powder bunkers.
    c. Impact craters.
5. Local knowledge.
    a. Local historian.
    b. TYAD Environmental Coordinator.
    c. Park and Game personnel.
    d. Stakeholders.
6. MC sampling results.

The ASR summarizes the site, historical ordnance presence, site eligibility for the FUDS program, and results of a visual site inspection, and provides an evaluation of ordnance and other site hazards. In the preparation of the ASR, historical records were searched and site interviews conducted with numerous personnel. The results of the effort are contained in detail in the

numerous appendices of the report, and provided the baseline of information used in the development of the initial conceptual site model (CSM) and plans.

EPA's National Exposure Research Laboratory, through its EPIC Center, analyzes historical records such as aerial imagery, historic and thematic maps, and other cartographic data for environmental site analyses and civil and criminal actions. Aerial imagery of the TOAR-FUDS was collected from between 1939 and 1999. The EPIC study further supported the ASR findings.

Historical maps not included in the ASR were located in 2003 during the initial project site visit. Several maps were found, but the most important map was a small scale 1920s era hand drawn range map, which was located in the Park Ranger's office. This map was used to validate other maps and known information on firing points (FPs) and target areas (TAs) at the TOAR-FUDS. This map detailed the placement of the ranges (firing points, targets and range fans) and was crucial in supporting the characterization of the site. Other maps were also located and used but were not as beneficial as the 1920s era map.

In total, approximately 578 acres of the site have been physically investigated or subjected to some form of removal action. In Park, total acres investigated were as follows:

- 1998 HFA TCRA – 187.5 acres were investigated in selected areas.
- 1998 HFA TCRA – 18 acres along were investigated hiking trails.
- 2004 WESTON RI – 31.71 acres were investigated using digital geophysical mapping (DGM).
- 2004 WESTON RI – 183.56 acres were investigated using instrument-aided reconnaissance (IAR).
- Site visits – numerous acres have been visually inspected during site visits.

In Game, total acres investigated were as follows:

- 2004 WESTON TCRA – 27 acres were investigated along roadways and trails.
- 2004 WESTON RI – 41.60 acres were investigated using DGM.
- 2004 WESTON RI – 86.73 acres were investigated using IAR.

- Site visits – numerous acres have been visually inspected during site visits.

During the 2004 WESTON RI, a total of 6,422 anomalies were selected for reacquisition and subsequent intrusive investigation. Of those 6,422 anomalies investigated, 78 UXO were recovered at the site: 40 UXO in Park, and 38 UXO in Game. Also, 3,367 MD were recovered, 2,584 non-MEC were recovered, and 392 false positives were identified. MD recovered included frag, base plates, empty projectiles, flash tubes, expended fuzes, and noses. At the TOAR-FUDS, empty projectiles were the principal MD that might have been indicative of a UXO presence. No DMM was recovered and no disposal pits were found at the site.

In addition to those items recovered during the 2004 WESTON RI, UXO recovered during previous activities include the following:

- 278 UXO recovered in Park (at the campground and along trails) during 1998 HFA TCRA.
- 228 UXO recovered on-post at TYAD (at the radar facility) during 1998 HFA construction support activities.
- 7 UXO recovered on-post at TYAD (adjacent to the radar facility) during 2004 WESTON construction support activities.
- 1 UXO recovered in Game (near 7-Mile Road and Jeep Trail) during 2004 WESTON TCRA.
- 3 UXO recovered in Park (near trails) during 2004 WESTON site visit.
- 2 UXO recovered in Park (near the northern FUDS boundary within the Lake Watawga Area) during 2004 CENAB site visit.

The largest artillery used at the TOAR-FUDS was 155-mm. All UXO recovered during all investigations were recovered in TAs and range fans (RFs) where UXO contamination was expected based on historical artillery range use. No DMM was recovered and no disposal pits were found. Therefore, no MEC was recovered that could be associated with former activities at FPs. Also, no UXO was recovered in Other Areas, which was expected because Other Areas were outside the area of expected or anticipated contamination.

Visual evidence was collected throughout the RI to locate MEC and to support characterization of the TOAR-FUDS for MEC. Visual evidence used to support site characterization for MEC

consisted primarily of the presence or absence of targets (i.e., wagons) and/or cratering in impact areas (IAs) and in buffer zones (BZs). Also, extensive local knowledge was supplied by area residents, a local historian, PGC and DCNR employees, and the TYAD Environmental Coordinator.

Based on the field data collected during the RI and during previous investigations at the TOAR-FUDS, and all other lines of evidence, revisions to the CSM were deemed necessary to account for high densities of UXO and MD recovered in some areas, and to account for the extensive cratering observed in some areas. To revise the CSM, TAs were first conservatively redrawn to include high densities of UXO, MD indicative of a potential UXO presence (empty projectiles), and heavily cratered areas. The TA boundaries were drawn to include the expected distribution of all UXO at a target, per U.S. Army Field Manual (FM) 6-40, Marine Corps Warfighting Publication (MCWP) No. 3-16.4, "Tactics, Techniques, and Procedures for Field Artillery Manual Cannon Gunnery" (U.S. Army, 1999). The TAs were shaped to closely resemble the generic TAs shown in historical range layouts, and were aligned in the general direction of the applicable FPs. IAs were then delineated based on the TAs, and BZs were delineated based on the IAs. Based on the revised CSM, all UXO recovered to date at the TOAR-FUDS are within expected areas of contamination (IAs and BZs). A separate area within Park and near Lake Watawga was identified as AOC TOAR-1 and is treated independently in the RI and in this FS, based on its proximity to residential housing. UXO densities (UXO items/acre investigated) were highest in IAs, and second highest in BZs. UXO densities were zero at FPs and in Other Areas.

The results of the RI were used to evaluate risk associated with UXO at the TOAR-FUDS. A qualitative risk evaluation was conducted using the Ordnance and Explosives Risk Impact Assessment (OERIA) Interim Guidance document (USACE, 2001) to assess explosive safety risks to the public at the TOAR-FUDS. The potential risks posed by UXO were characterized qualitatively by evaluating the following three primary risk factors and associated secondary risk factors:

1. Presence of a UXO source.
    a. Type.

b. Sensitivity.

c. Density.

d. Depth distribution.

2. Site Characteristics – Affect the accessibility or pathway between the source and human receptor.

   a. Site accessibility.

   b. Site stability.

3. Human Factors – Defines the number of receptors and type of activities that may result in direct contact between a receptor and UXO source.

   a. Site activity.

   b. Population.

Using those factors, risk associated with UXO at the TOAR-FUDS was evaluated for FPs, IAs, BZs, Other Areas, and the Lake Watawga area. The results of the risk evaluation were as follows:

- Firing Points – Risk associated with UXO is low.
- Impact Areas – Risk associated with UXO is high.
- Buffer Zones – Risk associated with UXO is low-moderate, depending on proximity to IAs.
- Lake Watawga Area – Risk associated with UXO is high.
- Other Areas – Risk associated with UXO is low.

1.3.2 Munitions Constituents

The intent of the environmental sampling program for this project was to assess the potential of MC contamination resulting from the use of munitions at the TOAR-FUDS, not to provide full site characterization. Therefore, soil, sediment, and surface water samples were collected at biased-high locations (ordnance features, such as detonation craters and disposal pits, and analyzed for metals and explosives) with the highest potential for MC contamination.

The results of environmental sampling for MC were analyzed three ways in the screening level risk assessment: 1) results for Park only, 2) results for Game only, and 3) results for Park and Game combined. The results were analyzed three ways to ensure that elevated concentrations in either Park or Game would not be masked in a combined, site-wide assessment.

Only one explosive was detected above method detection limits. HMX was detected in one soil sample collected from FP #2A at a concentration of 0.069 mg/kg, which is above the method detection limit (0.048 mg/kg), but below the reporting limit (0.50 mg/kg). The lack of explosives detected above method detection limits in any other samples helps eliminate explosives as potential contaminants of concern.

Several metals were detected in soil, sediment and surface water samples at concentrations exceeding background levels:

- Lead was detected in all soil samples, all sediment samples, and five of six surface water samples. Maximum concentrations of lead in soil (611 mg/kg) and surface water (31.5 mg/kg) exceed background or reference values.
  - Human Health – Although lead was found to be statistically significant different from background soil levels in Park only samples, lead only exceeded the lowest screening benchmark in 1 of the 45 analyzed samples with a concentration of 611 mg/kg. The lowest screening benchmark was the EPA Office of Solid Waste and Emergency Response (OSWER) residential screening level (400 mg/kg). The arithmetic mean for lead for the Park data (with the highest mean of all three areas) was 136 mg/kg which is well below the EPA OSWER residential value. Therefore, the impact of site lead levels is small relative to background and not likely to pose a human health threat at the Tobyhanna site.
  - Ecological – Lead exceeded background levels and lowest ecological benchmarks in only 2 of 45 soil samples (1 in Park, 1 in Game) and 5 of 6 surface water samples. Although the surface water concentrations of lead in 5 of 6 sampling locations exceeded ambient water quality criteria (AWQC), several conservative assumptions were made in this analysis, as discussed in subsection 7.2.2.6.2. Based on the sampling results and the uncertainty inherent in ecological benchmarks, lead detected at the site is not expected to pose an ecologically significant risk to terrestrial organisms at the site.
- Copper was also detected in all soil samples, all sediment samples, and five of six surface water samples. Maximum concentrations of copper in soil (167 mg/kg) and sediment (31.5 mg/kg) exceed background or reference values.

- Human Health – Although copper exceeded background or reference values, copper did not exceed lowest residential screening benchmarks for human health. Therefore, copper is not a chemical of potential concern at the Tobyhanna site.

- Ecological – Copper exceeded background levels and lowest ecological benchmarks in only 3 of 45 soil samples (all in Park). Based on the sampling results and the uncertainty inherent in ecological benchmarks, copper detected at the site is not expected to pose an ecologically significant risk to organisms at the site.

▪ Antimony was detected in 38 of 44 soil samples, and the maximum concentration of antimony in surface soils (10 mg/kg) exceeds background or reference values.

- Human Health – Although antimony was found to be statistically significant different from background soil levels in all sample combinations (combined Park and Game samples, Park only samples, and Game only samples), antimony only exceeded the lowest screening benchmark in 6 of the 45 analyzed samples. The lowest screening benchmark was the residential soil risk-based concentration (RBC) (3.13 mg/kg) which was adjusted for preliminary screening purposes to a target hazard quotient (THQ) of 0.1. No antimony samples would exceed the residential RBC at a THQ of 1.0 (31.3 mg/kg). Furthermore, no antimony samples exceed the industrial RBC (40.9 mg/kg), PA DEP MSCs for direct contact (1100 mg/kg) or soil to groundwater protection (27 mg/kg). Therefore, the impact of site antimony levels is small relative to background and not likely to pose a human health threat at the Tobyhanna site.

- Ecological – Antimony exceeded background levels and lowest ecological benchmarks in only 4 of 45 soil samples (3 in Park, 1 in Game). Based on the sampling results and the uncertainty inherent in ecological benchmarks, antimony detected at the site is not expected to pose an ecologically significant risk to organisms at the site.

Potential pathways for these metals include: airborne dust particles; waterborne particles in storm or river runoff; dissolution in storm runoff or other surface water movement; and dissolution in groundwater. Airborne dust is not considered a problem. Retained strongly in soil, very little lead, copper and antimony is expected to be transported into surface water or groundwater in the dissolved state leaving the only pathway of possible concern is waterborne metal-rich sediments in storm and river runoff.

The transport and mobility of both lead and copper increases with low soil or water pH, high amounts of annual precipitation, and the absence of organic compounds in the soil. Similarly, the strength of antimony's adsorption to soil and sediments appears to be dependent upon a variety of factors such as pH, organic matter content, as well as the oxidation state of the

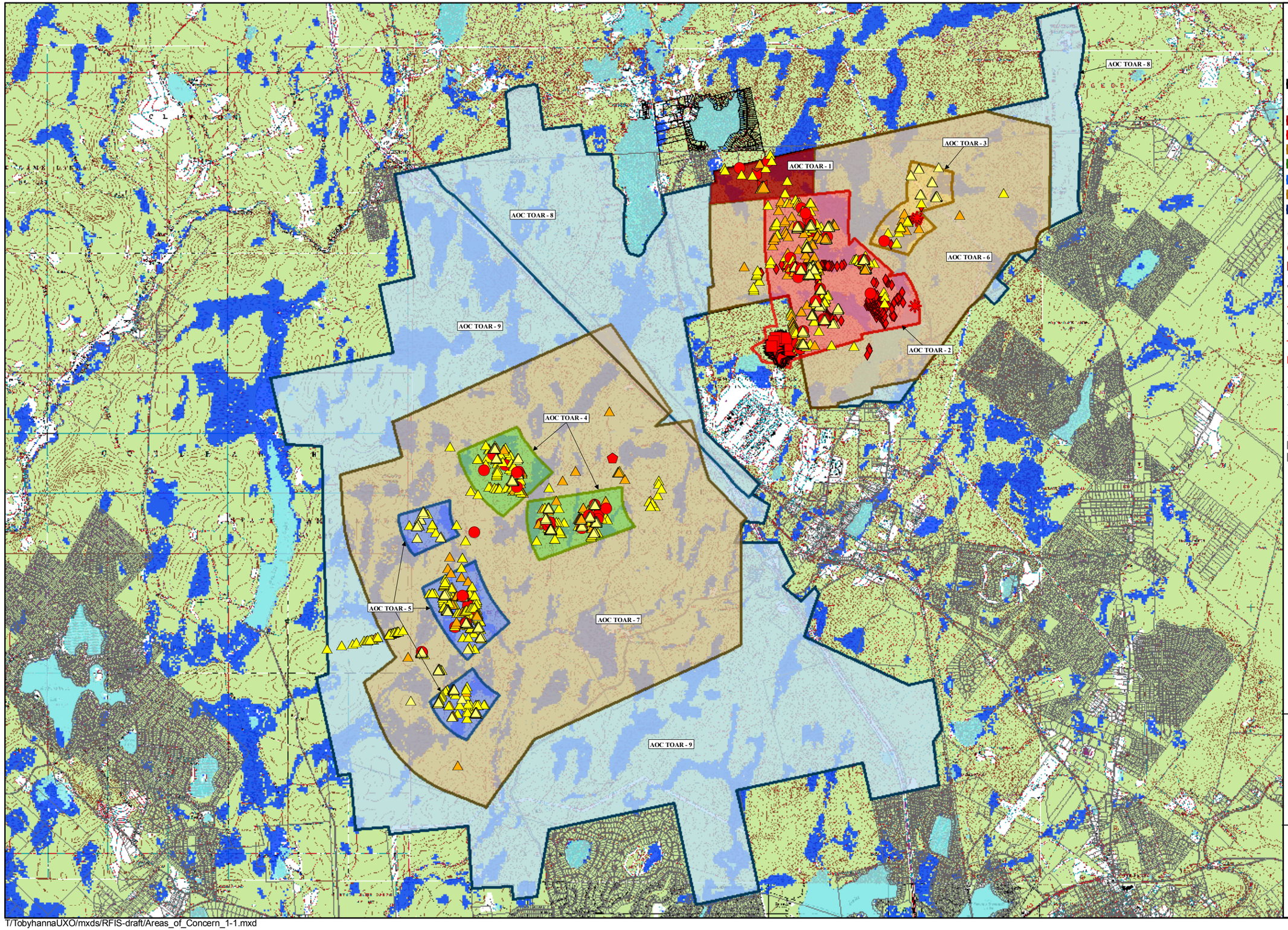
particular salt. In water, it usually adheres to sediments. Soil type, organic matter content, topography and the extent of vegetative cover also play a significant role in the transport and mobility of these metals. Soils within the TOAR-FUDS are developed in loamy, glacial deposits derived from shales, siltstones and sandstones with pH values ranging from 4.5 to 6 and a thick, slowly permeable fragipan subsoils. Such soils tend to inhibit vertical migration of the metals while increasing residence time and the probability for electrostatic bonding and adsorption of the metals to soils particles. Field personnel describe soils encountered during the RI as having a thick root/organic layer that also enhances bonding and adsorption to soils. Lastly, the highly vegetated swamp and surrounding forested areas further decrease the potential for movement of sediment to local streams and ponds.

Based on the results of the risk assessments conducted for MC, as well as the fate and transport analysis, the concentrations of MC present at the TOAR-FUDS do not pose unacceptable risk to human health or the environment and do not pose an explosive hazard, and additional evaluation or sampling for MC is not warranted. Therefore, there are no specific chemical constituents of concern associated with the TOAR-FUDS.

1.3.3 Conclusions of Remedial Investigation

The data collected during the RI supports the original CSM. UXO and MD were found in areas of expected contamination (Target Areas and Range Fans), and no UXO were found in Other Areas, as expected. The original CSM was revised only slightly to account for historic artillery range layouts and varying densities of UXO and MD indicative of a UXO presence, but the original CSM was essentially unchanged.

Based on the revised CSM, UXO densities, and the results of the risk evaluation, nine (9) areas of concern (AOCs) have been identified at the TOAR-FUDS. The AOCs are summarized in Table 1-1 and shown in Figure 1-1. The lines of evidence used to characterize the AOCs are summarized in Table 1-2. As summarized in Table 1-1, five (5) AOCs have high risk associated with UXO, two (2) AOCs have low-moderate risk associated with UXO, and two (2) AOCs have low risk associated with UXO. The AOCs with high risk represent impact areas at the TOAR-FUDS, while AOCs with low-moderate risk represent BZs, and AOCs with low risk represent Other Areas at the TOAR-FUDS. Also shown in Table 1-1 is the estimated acreage of wetlands



Legend

- FUDS Boundary

Areas of Concern (AOC)

- AOC TOAR - 1
- AOC TOAR - 2
- AOC TOAR - 3
- AOC TOAR - 4
- AOC TOAR - 5
- AOC TOAR - 6 & 7
- AOC TOAR - 8 & 9

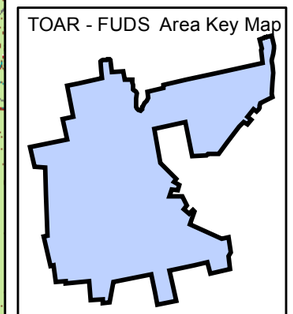
Anomaly Type

- UXO - WESTON RI
- UXO - WESTON CONSTR. SUPPORT (TYAD)
- UXO - WESTON TCRA
- UXO - WESTON SITE WALK
- UXO - HFA TCRA
- UXO - HFA TYAD
- UXO - HFA CONSTR. SUPPORT (TYAD)
- MD - WESTON RI
- MD - WESTON RI & TCRA (EMPTY PROJECTILE)

Wet Areas

- Wetland Areas
- Water Bodies

TOAR - FUDS Area Key Map



N W E S

0 1,250 2,500 5,000 Feet

Figure 1-1
Areas of Concern
at TOAR - FUDS

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Table 1-1 Areas of Concern at the TOAR-FUDS

Area of Concern	Location	Total AOC Acreage	Wet AOC Acreage[1]	Total Accessible Acreage[2]	Acres Investigated During 2004 RI		Approx. Acres Investigated During All Previous Investigations	Total Approx. Acres Investigated in AOC[3]	UXO Recovered in AOC During 2004 RI	UXO Recovered in AOC During All Previous Investigations	Total UXO Recovered in AOC[4]	Physical Features and Land Uses	UXO Risk
					DGM	IAR							
AOC TOAR-1	Lake Watawga Area	265	99	166	0.42	54.05	1	55	2	2	4	Adjacent residential housing	High
AOC TOAR-2	Impact Area Park	1103	266	837	8.59	25.64	201	235	37	270	307	Camping, hiking, fishing, mountain biking, snowmobiling	High
AOC TOAR-3	Impact Area Park	254	98	156	4.44	2.23	2	9	1	6	7	Camping, hiking, fishing, mountain biking, snowmobiling	High
AOC TOAR-4	Impact Area Game	656	142	514	6.42	9.21	0	16	28	0	28	Hunting, fishing, hiking, mountain biking, snowmobiling	High
AOC TOAR-5	Impact Area Game	625	126	499	10.45	6.64	0	17	7	0	7	Hunting, fishing, hiking, mountain biking, snowmobiling	High
AOC TOAR-6	Buffer Zone Park	2908	612	2296	8.91	54.29	3	66	0	5	5	Camping, fishing, hiking, mountain biking, snowmobiling	Low-Moderate
AOC TOAR-7	Buffer Zone Game	7304	1577	5727	11.21	36.25	20	67	3	1	4	Hunting, fishing, hiking, fishing, mountain biking, snowmobiling	Low-Moderate
AOC TOAR-8	Other Areas Park	3790	525	3265	9.20	49.37	0	59	0	0	0	Adjacent residential housing, hiking, fishing, mountain biking, snowmobiling	Low
AOC TOAR-9	Other Areas Game	4195	1847	2348	13.66	34.40	7	55	0	0	0	Adjacent residential housing, hunting, fishing, hiking, mountain biking, snowmobiling	Low

[1]Wet acreage based on GIS coverage of TOAR-FUDS from 2000, and includes lakes, ponds, streams, wetlands, etc.

[2]Total accessible acreage = Total acreage – Total wet acreage.

[3]Total approximate acres investigated = Acres investigated during 2004 RI + Approximate acres investigated during all previous investigations.

[4]Total UXO recovered = UXO recovered during 2004 RI + UXO recovered during all previous investigations.

Table 1-2 Lines of Evidence for Areas of Concern at the TOAR-FUDS

Area of Concern	Location	Historical Information	EPA Photo Analysis Report	UXO Presence	Range Layout/ Characteristics	MD Presence	Visual Evidence	Local Populace/ Workers Knowledge	IAR or DGM Data?	MC Presence
AOC TOAR-1	Lake Watawga Area	ASR	N	4	Previously part of Range Fans	Y	CENAB Site Visit	Not identified by local populace or workers	Y	N
AOC TOAR-2	Impact Area Park	ASR 1918 Map 1932 Map	Y	307	Historic and Current	Y	Weston Site Visit Target Remnants Impact Craters	Local Historian Park & Game Workers Stakeholders	Y	N
AOC TOAR-3	Impact Area Park	ASR 1918 Map 1932 Map	Y	7	Historic and Current	Y	Target Remnants Impact Craters	Local Historian Park & Game Workers Stakeholders	Y	N
AOC TOAR-4	Impact Area Game	ASR 1918 Map 1932 Map	Y	28	Historic and Current	Y	Target Remnants Impact Craters	Local Historian Park & Game Workers Stakeholders	Y	N
AOC TOAR-5	Impact Area Game	ASR 1918 Map 1932 Map	Y	7	Historic and Current	Y	Target Remnants Impact Craters	Local Historian Park & Game Workers Stakeholders	Y	N
AOC TOAR-6	Buffer Zone Park	ASR 1918 Map 1932 Map	Y	5	Historic and Current	Y	Powder Bunkers No mass cratering	Local Historian Park & Game Workers Stakeholders	Y	N
AOC TOAR-7	Buffer Zone Game	ASR 1918 Map 1932 Map	Y	4	Historic and Current	Y	Powder Bunkers No mass cratering	Local Historian Park & Game Workers Stakeholders	Y	N
AOC TOAR-8	Other Areas Park	Remaining Areas Outside Range Fans	N	0	Remaining Areas Outside Range Fans	Y	No Target Remnants No Impact Craters No Powder Bunkers	Local Historian Park & Game Workers Stakeholders	Y	N
AOC TOAR-9	Other Areas Game	Remaining Areas Outside Range Fans	N	0	Remaining Areas Outside Range Fans	Y	No Target Remnants No Impact Craters No Powder Bunkers	Local Historian Park & Game Workers Stakeholders	Y	N

Y = Yes.

N = No.

in each AOC. Wetlands are present throughout the TOAR-FUDS (approximately 25% of the site is covered by wetlands), and will be considered during the identification of technologies for remedial alternatives, during the detailed evaluation of remedial alternatives, and when calculating costs for remedial alternatives. Remedial alternatives for all nine (9) AOCs will be evaluated in this FS to address the risk posed by UXO at the TOAR-FUDS.

1.4 REMEDIAL ACTION OBJECTIVES

The goal of a remedial action is to reduce explosives safety hazards or contaminants of concern to ensure protection of human health, public safety, and the environment. To achieve this goal at the TOAR-FUDS, the appropriateness and effectiveness of potential remedial actions in the nine (9) AOCs for minimizing the public's exposure to UXO while maintaining the intended future land use of public access for recreational activities will be evaluated in this FS.

The objectives established for remedial actions will guide the development of alternatives for each AOC within the TOAR-FUDS and focus the comparison of acceptable remedial action alternatives, if warranted. These objectives will also assist in clarifying the goal of minimizing the explosive risk and achieving an acceptable level of protection for human health and the environment. These objectives include:

- Reduce or eliminate potential UXO exposure pathways.
- Meet NCP criteria.

2. APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS AND TO BE CONSIDERED CRITERIA

Three categories of applicable or relevant and appropriate requirements (ARARs) are evaluated for the TOAR-FUDS, along with to be considered criteria (TBCs). The ARAR categories are: chemical-specific, location-specific, and action-specific.

Chemical-specific ARARs are health-based or risk-based numerical values that establish the acceptable amount or concentration of a chemical that may remain in, or be discharged to, the ambient environment. Preliminary chemical-specific ARARs were identified in the RI to provide benchmarks with which to compare environmental sampling results for metals and explosives at the TOAR-FUDS. The benchmarks were used in the human health and ecological screening level risk assessments in the RI. However, the results of the risk assessments indicated that there are no specific chemical constituents of concern associated with the TOAR-FUDS. Therefore, chemical-specific ARARs are not considered in this FS.

Location-specific ARARs generally are restrictions placed on the concentration of hazardous substances or the conduct of activities to prevent damage to unique or sensitive areas, such as floodplains, wetlands, historic places, and sensitive ecosystems or habitats. Several location-specific ARARs have been identified. These location-specific ARARs will be reviewed prior to implementation of cleanup action alternatives at the TOAR-FUDS. The location-specific ARARs include protection of historical and archaeological resources, and protection of wildlife and habitat resources, including endangered species, fish, migratory birds, and wetlands.

Action-specific ARARs are usually technology or activity-based requirements or limitations placed on actions taken with respect to cleanup actions, or requirements to conduct certain actions to address particular circumstances at a site.

TBCs are used when there are no ARARs, or when ARARs alone may not adequately protect human health and the environment.

ARARs and TBCs identified for the TOAR-FUDS are summarized in Table 2-1.

Table 2-1 Applicable or Relevant and Appropriate Requirements and To Be Considered Criteria

ARAR/TBC	Citation	Applicability or Relevance
Location-Specific ARARs – Location of an action within an area where it may cause irreparable harm, loss, or destruction of significant artifacts or historic landmarks		
36 CFR 800, excluding section 800.8 – Protection of historic properties (Section 106 of the National Historic Preservation Act, as amended)	(a) *Purposes of the section 106 process.* Section 106 of the National Historic Preservation Act requires Federal agencies to take into account the effects of their undertakings on historic properties and afford the Council a reasonable opportunity to comment on such undertakings.	Historic property may exist at the TOAR-FUDS. The procedures in 36 CFR 800 describe how Federal agencies meet these statutory responsibilities: by identifying historic properties potentially affected by the undertaking, assessing the effects, and seeking ways to avoid, minimize, or mitigate any adverse effects on historic properties.
33 CFR 320.4 – General policies for evaluating permit applications.	(1) Most wetlands constitute a productive and valuable public resource, the unnecessary alteration or destruction of which should be discouraged as contrary to the public interest. For projects to be undertaken or partially or entirely funded by a federal, state, or local agency, additional requirements on wetlands considerations are stated in Executive Order 11990, dated 24 May 1977. (4) No permit will be granted which involves the alteration of wetlands identified as important by paragraph (b)(2) of this section or because of provisions of paragraph (b)(3) of this section unless the district engineer concludes, on the basis of the analysis required in paragraph (a) of this section, that the benefits of the proposed alteration outweigh the damage to the wetlands resource.	Approximately 25% of the TOAR-FUDS consists of wet areas. This Part and the Parts that follow (33 CFR Parts 321-330) prescribe the statutory authorities, and general and special policies and procedures applicable to the review of applications for Department of the Army (DA) permits for controlling certain activities in waters of the United States or the oceans. This part identifies the various federal statutes which require that DA permits be issued before these activities can be lawfully undertaken; and related Federal laws and the general policies applicable to the review of those activities.
Executive Order 11990	Sec. 5. In carrying out the activities described in Section I of this Order, each agency shall consider factors relevant to a proposal's effect on the survival and quality of the wetlands. Among these factors are: (a) public health, safety, and welfare, including water supply, quality, recharge and discharge; pollution; flood and storm hazards; and sediment and erosion; (b) maintenance of natural systems, including conservation and long term productivity of existing flora and fauna, species and habitat diversity and stability, hydrologic utility, fish, wildlife, timber, and food and fiber resources; and (c) other uses of wetlands in the public interest, including recreational, scientific, and cultural uses.	Approximately 25% of the TOAR-FUDS consists of wet areas. This order was issued to avoid to the extent possible the long and short term adverse impacts associated with the destruction or modification of wetlands and to avoid direct or indirect support of new construction in wetlands wherever there is a practicable alternative.

Table 2-1 Applicable or Relevant and Appropriate Requirements and To Be Considered Criteria (continued)

ARAR/TBC	Citation	Applicability or Relevance
16 U.S.C. 1536 (Endangered Species Act of 1973, as amended)	2) Each Federal agency shall, in consultation with and with the assistance of the Secretary, insure that any action authorized, funded, or carried out by such agency (hereinafter in this section referred to as an "agency action") is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat of such species which is determined by the Secretary, after consultation as appropriate with affected States, to be critical, unless such agency has been granted an exemption for such action by the Committee pursuant to subsection (h) of this section. In fulfilling the requirements of this paragraph each agency shall use the best scientific and commercial data available.	Endangered and threatened species are present at the TOAR-FUDS, as described in Section 2 of the RI report. The purposes of this section of the Endangered Species Act are to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, to provide a program for the conservation of such endangered species and threatened species, and to take such steps as may be appropriate to achieve the purposes of the treaties and conventions set forth in subsection (a) of this section. This Act requires interagency cooperation to ensure that authorized actions do not jeopardize the continued existence of endangered or threatened species, or their habitats.
Action-Specific ARARs		
25 Pa. Code 102.11 – Erosion and sediment control BMPs; General requirements	(a) A person conducting or proposing to conduct an earth disturbance activity shall design, implement and maintain BMPs to minimize the potential for accelerated erosion and sedimentation in order to protect, maintain, reclaim and restore water quality and existing and designated uses. Various BMPs and their design standards are listed in the Erosion and Sediment Pollution Control Program Manual (Manual), Commonwealth of Pennsylvania, Department of Environmental Protection, No. 363-2134-008 (January 1996), as amended and updated. (b) BMPs and design standards other than those listed in the Manual may be used when a person conducting or proposing to conduct an earth disturbance activity demonstrates to the Department or a county conservation district that the alternate BMP or design standard minimizes accelerated erosion and sedimentation to achieve the regulatory standards in subsection (a).	UXO removal activities would require excavation of some kind. 25 Pa. Code 102 requires persons proposing or conducting earth disturbance activities to develop, implement and maintain BMPs to minimize the potential for accelerated erosion and sedimentation.

Table 2-1 Applicable or Relevant and Appropriate Requirements and To Be Considered Criteria (continued)

ARAR/TBC	Citation	Applicability or Relevance
25 Pa. Code 102.22 – Erosion and sediment control BMPs; Permanent stabilization	(a) Upon completion of an earth disturbance activity or any stage or phase of an activity, the site shall be immediately seeded, mulched or otherwise protected from accelerated erosion and sedimentation. (b) Erosion and sediment control BMPs shall be implemented and maintained until the permanent stabilization is completed. (c) For an earth disturbance activity or any stage or phase of an activity to be considered permanently stabilized, the disturbed areas shall be covered with one of the following: (1) A minimum uniform 70% perennial vegetative cover, with a density capable of resisting accelerated erosion and sedimentation. (2) An acceptable BMP which permanently minimizes accelerated erosion and sedimentation.	UXO removal activities would require excavation of some kind. 25 Pa. Code 102 requires persons proposing or conducting earth disturbance activities to develop, implement and maintain BMPs to minimize the potential for accelerated erosion and sedimentation.
25 Pa. Code 123.2 – Standards for contaminants; Fugitive particulate matter	A person may not permit fugitive particulate matter to be emitted into the outdoor atmosphere from a source specified in § 123.1(a)(1)—(9) (relating to prohibition of certain fugitive emissions) if the emissions are visible at the point the emissions pass outside the person's property.	UXO removal activities would require excavation of some kind, which could result in fugitive particulate matter. 25 Pa. Code 123 provides standards for contaminants in air emissions.
40 CFR 264 Subpart X – Standards for owners and operators of hazardous waste treatment, storage, and disposal facilities; Miscellaneous units	264.601 A miscellaneous unit must be located, designed, constructed, operated, maintained, and closed in a manner that will ensure protection of human health and the environment.	UXO disposal could require the use of technologies defined as "miscellaneous units" in Subpart X, including open burn/open detonation (OB/OD) units, shredders, crushers, etc. Subpart X outlines procedures for issuing permits to miscellaneous units that treat, store, or dispose of hazardous waste. Miscellaneous units include OB/OD units, enclosed combustion devices, carbon and catalyst regeneration units, thermal desorption units, shredders, crushers, filter presses and geologic repositories. Subpart X does not specify minimum technology requirements or monitoring requirements for miscellaneous units. Subpart X specifies an environmental performance standard that must be met through conformance with appropriate design, operating, and monitoring requirements.

Table 2-1 Applicable or Relevant and Appropriate Requirements and To Be Considered Criteria (continued)

ARAR/TBC	Citation	Applicability or Relevance
TBCs		
Memo, DoD and EPA, Interim Final, 7 March 2000 – "DoD and EPA Interim Final Management Principles for Implementing Response Actions at Closed, Transferring, and Transferred (CTT) Ranges"	A permanent record of the data gathered to characterize a site and a clear audit trail of pertinent data analysis and resulting decisions and actions are required. To the maximum extent practicable, the permanent record shall include sensor data that is digitally-recorded and geo-referenced.	This document provides interim guidance for ongoing response actions addressing MEC at CTT Ranges, such as the TOAR-FUDS.

3. IDENTIFICATION AND SCREENING OF TECHNOLOGIES

This section identifies and describes general remedial actions and potential UXO remedial technologies for the TOAR-FUDS. The general remedial actions identified and described in this section will be analyzed in the Development and Screening of Alternatives (Section 4) and Detailed Analysis (Section 5) sections of this report. Each technology identified in this section is screened for effectiveness, implementability, and cost to evaluate their viability at the TOAR-FUDS.

3.1 GENERAL REMEDIAL ACTIONS

General remedial actions are those actions that will achieve the remedial action objectives. The following general remedial actions will be considered at the TOAR-FUDS:

- **No Action** – The No Action alternative is evaluated to satisfy the NCP requirement of 40 CFR 300.430(e)(6), which requires consideration of this alternative as a baseline against which other alternatives may be compared.
- **Land Use Controls (LUCs)** – Land use controls are considered a "limited" action alternative by the EPA, and include components of access control and/or public education (EPA, 1988).
- **UXO removal** – UXO can be detected and removed from the ground surface and/or below the ground surface. Alternatives for UXO removal will include technologies for UXO detection, positioning, UXO removal, and UXO disposal.

3.2 IDENTIFICATION AND SCREENING OF UXO REMEDIAL TECHNOLOGIES

3.2.1 Screening Criteria

UXO remedial technologies are first evaluated against three general categories of effectiveness, implementability, and cost to ensure that they meet the minimum standards of the criteria within each category in the FS process. The three general categories are first used to screen the technologies described in subsection 3.2.2 and later used to screen the alternatives developed in subsection 4.1. The three general categories are described below.

3.2.1.1 Effectiveness

Technologies or alternatives that have been identified should be evaluated further on their effectiveness relative to other processes within the same technology/alternative type. This evaluation should focus on: (1) the potential effectiveness of technology/alternative options in handling the estimated areas or volumes of media and meeting the remediation goals identified in the RAOs; (2) the potential impacts to human health and the environment during the construction and implementation phase; and (3) how proven and reliable the technology/alternative is with respect to the contaminants and conditions at the site (EPA, 1988).

3.2.1.2 Implementability

Implementability, as a measure of both the technical and administrative feasibility of constructing, operating, and maintaining a remedial action alternative, is used during screening to evaluate the combinations of technology/alternative options with respect to conditions at a specific site. Technical feasibility refers to the ability to construct, reliably operate, and meet technology-specific regulations for technology/alternative options until a remedial action is complete; it also includes operation, maintenance, replacement, and monitoring of technical components of a technology/alternative, if required, into the future after the remedial action is complete. Administrative feasibility refers to the ability to obtain approvals from other offices and agencies, the availability of treatment, storage, and disposal services and capacity, and the requirements for, and availability of, specific equipment and technical specialists (EPA, 1988).

The determination that a technology/alternative is not technically feasible will usually preclude it from further consideration unless steps can be taken to change the conditions responsible for the determination. Typically, this type of "fatal flaw" will be identified during technology screening, and an alternative consisting of infeasible technology will not be assembled. Negative factors affecting administrative feasibility will normally involve coordination steps to lessen the negative aspects of the technology/alternative but will not necessarily eliminate a technology/alternative from consideration (EPA, 1988).

3.2.1.3 Cost

Typically, technologies/alternatives will have been defined well enough before screening that some estimates of cost are available for comparisons among technologies/alternatives. However, because uncertainties associated with the definition of technologies/alternatives often remain, it may not be practicable to define the costs of technologies/alternatives with the accuracy desired for the detailed analysis (i.e., +50 percent to -30 percent) (EPA, 1988).

According to EPA guidance, a high level of accuracy in cost estimates during screening is not required. The focus should be to make comparative estimates for technologies/alternatives with relative accuracy so that cost decisions among technologies/alternatives will be sustained as the accuracy of cost estimates improves beyond the screening process.

In the detailed analysis in Section 5, when the costs of remedial action alternatives are evaluated, both capital and O&M costs will be considered, where appropriate. The evaluation will include those O&M costs that will be incurred for as long as necessary, even after the initial remedial action is complete. In addition, potential future remedial action costs will be considered during alternatives evaluation to the extent they can be defined. Present worth analyses will be used during alternatives evaluation to evaluate expenditures that occur over different time periods. By discounting all costs to a common base year, the costs for different technologies/alternatives can be compared on the basis of a single figure for each alternative. Included in each cost calculation is an estimate as to the amount of time that will be necessary to complete the proposed alternative.

3.2.2 Evaluation of Technologies

Various technologies and approaches exist for the remediation of UXO. UXO removal activities include three steps: detection, removal, and disposal. A description of the technologies used in each step is presented in the following subsections. At the end of each subsection, the technologies are screened against the three screening criteria to determine their viability at the TOAR-FUDS.

3.2.2.1 UXO Detection

UXO detection includes those methods and instruments used to locate surface and subsurface UXO. The best detection method is selected based on the UXO properties, such as the depth and size of the suspected UXO items, and the physical characteristics of the site, such as soil type, topography, vegetation, and geology.

There are two basic forms of UXO detection. The first, visual searching, has been successfully used on a number of sites where UXO is located on the ground surface. When performing a visual search of a site, the area to be searched is typically divided into five-foot lanes that are systematically inspected for UXO. A metal detector is sometimes used to supplement the visual search in areas where ground vegetation may conceal surface UXO. Typically, any UXO found during these searches is flagged or marked on a grid sheet for immediate removal.

The second form of UXO detection, geophysics, includes a family of detection instruments designed to locate subsurface UXO, and equipment and methods used for positioning. The family of instruments designed to locate subsurface UXO includes magnetic instruments, electromagnetic instruments, and ground penetrating radar (GPR). Each piece of equipment has its own inherent advantages and disadvantages based on its operating characteristics, making the selection of the type of geophysical instrument paramount to the survey success.

Positioning technologies include various methods and instruments that establish geo-referenced data for anomalies located using UXO detection technologies. Each method and/or instrument has its own inherent advantages and disadvantages based on its operating characteristics, making the selection of the type of positioning method paramount to the survey success. Positioning technologies are impacted on site primarily by terrain, including canopy, the density of trees, and topography.

UXO detection technologies and positioning technologies/methods are described in Tables 3-1 and 3-2, respectively. Tables 3-1 and 3-2, which are based on technical RI/FS guidance for MMRP sites distributed by CEHNC, include technologies that were tested and used at the TOAR-FUDS during the geophysical prove-out (GPO) and the RI. The technologies described in Tables 3-1 and 3-2 are screened against the three criteria of effectiveness, implementability,

Table 3-1 UXO Detection Technologies

Technology	Effectiveness	Implementability	Cost	Representative Systems	Notes	Viability at TOAR-FUDS
Visual Searching	**Low - Medium:** Effective for surface removals in open areas with little ground cover. Not appropriate for subsurface removals.	**Medium - High:** Easily implemented by trained UXO personnel.	**Low** Lower than other methods that require equipment.	NA		**Medium** Many UXO items found on or near surface at TOAR-FUDS during RI, but significant amount of ground cover and difficult terrain.
Magnetometers – Analog (Flux-Gate)	**Medium - High:** Have been used as the primary detector in some highly ranked systems. High industry familiarization. Detects ferrous objects only. Schoenstedt GA-52Cx and Schoenstedt GA-72Cd were tested and proven effective during the GPO at the TOAR-FUDS. Both systems were used effectively for Mag and Dig (M&D) during the RI at the TOAR-FUDS.	**High:** Light and compact. Can be used in any traversable terrain. Widely available from a variety of sources.	**Low** Lower than other methods on most terrains.	Schoenstedt GA-52Cx Schoenstedt GA-72Cd Foerster FEREX 4.032 Ebinger MAGNEX 120 LW	Analog output not usually co-registered with navigational data	**High** Technology proven effective at TOAR-FUDS during GPO and RI.
Magnetometers – Digital data logging (Atomic-Vapor)	**High:** Used in several highly ranked systems. High industry familiarization. Detects ferrous objects only. Geometrics G-858 was tested and proven effective during GPO at the TOAR-FUDS. The system was used effectively for digital geophysical mapping (DGM) during the RI at the TOAR-FUDS.	**Medium - High:** Relatively light and compact and can be easily used in open areas. Can be used in most traversable terrain. Widely available from a variety of sources. Processing and interpretation requires trained specialists. Discrimination possibilities are limited to magnetic susceptibility/magnetic moment estimates and depth estimates. Detection capabilities are influenced by iron-bearing soils.	**Low – Medium** Dependent on terrain. Much lower when arrays of multiple detectors are used.	Geometrics G-858 Geometrics G-822 Scientrex Smart Mag G-tek TM4	Digital signal should be co-registered with navigational data for best results.	**High** Technology proven effective at TOAR-FUDS during GPO and RI.
Time-Domain Electromagnetic Induction Metal Detectors	**High:** Used in several highly ranked systems. High industry familiarization. Detects both ferrous and non-ferrous metallic objects. Geonics EM61-MK2 was tested and proven effective during GPO at the TOAR-FUDS.	**Low:** Typically utilizes transceiver coil one meter wide, but small versions are also available. Can be used in most traversable terrain. Most commonly used instrument is widely available. Processing and interpretation are relatively straight forward. Discrimination possibilities exist for multi-channel systems. Geonics EM61-MK2 was not used during RI at the TOAR-FUDS because terrain (trees, heavy brush, boulders/rock) was unsuitable for equipment.	**Low – Medium** Dependent on terrain. Much lower when arrays of multiple detectors are used.	Geonics EM61 Geonics EM61-hh Geonics EM61-MK2 G-tek TM5-EMU Vallon VMH3	Digital signal should be co-registered with navigational data for best results. Detection depths are highly dependent on coil size and power throughput.	**Medium** Technology proven effective during GPO, but difficult to implement due to terrain at TOAR-FUDS.
Frequency-Domain Electromagnetic Induction Metal Detectors	**Medium - High:** Not been the primary detector in any highly-ranked systems. However, experience demonstrates capability of detecting small items. Not good for detecting deeply buried, single items. High industry familiarization. Detects both ferrous and non-ferrous metallic objects. Of note, the Geophex GEM system has been ranked highly during DoD testing	**High:** Hand-held detectors are light and compact. Can be used in any traversable terrain. Widely available from a variety of sources. Discrimination possibilities exist among some multi-channel systems and some handheld systems.	**High** Instruments are slow and can detect very small items.	Scheibbel ANPSS-12 White's All Metals Detector Fisher 1266X Garrett Geophex GEM3	Analog output not usually co-registered with navigational data. Digital output should be co-registered with navigational data	**Medium** Technology not proven at TOAR-FUDS. Detects all metals, instead of only ferrous items. Relatively high cost.
Sub Audio Magnetics	**Medium - High:** Detects both ferrous and non-ferrous metallic objects. Capable tool for detection of deep UXO. Low industry familiarization, System has seen limited application.	**Low:** High data processing requirements. Available from few sources. High power requirements. Longer than average setup times.	**High** Partially due to limited availability.	G-tek SAM	Not commercially available. No established track record.	**Low** Difficult to implement, high cost, not commercially available.
Magnetometer-Electromagnetic Detection Dual Sensor Systems	**Medium - High:** Detects both ferrous and non-ferrous metallic objects. Medium industry familiarization. Higher potential for discrimination.	**Low:** High data processing requirements. Available from few sources. Towed array is not implementable at the TOAR-FUDS.	**Medium – High** Costs are lower when using a towed array platform. Limited availability.	AETC EM61-hh & G-822 MTADS GEOCENTERS STOLS	Not commercially available still under development	**Low** Difficult to implement, high cost, not commercially available. Towed array is not implementable at the TOAR-FUDS.

Table 3-1 UXO Detection Technologies (continued)

Technology	Effectiveness	Implementability	Cost	Representative Systems	Notes	Viability at TOAR-FUDS
Marine Side-Scan Sonar	**Low:** Visualizes shapes of both metallic and non-metallic objects. Only detects items on surface of water body floor. Low industry familiarization.	**Medium:** Requires trained operator, experienced field crew, calm water may be needed. Vegetation can hinder acoustic signal propagation, and large floating vegetation mats and dense root growth are common throughout wetlands at the TOAR-FUDS.	**Medium** For marine investigations.	Klein 5500, EdgeTech DF-1000, Triton Elics Sonar Suite, GeoAcoustics, Fishers SSS-100K/600K, Marin Sonic Technologies	Few have applied these technologies to the UXO problem.	**Low** Wetlands at the TOAR-FUDS contain sufficient vegetation to hinder signal.
Airborne Multi- or Hyper- spectral Imagery	**Low:** Detects both metallic and non-metallic objects. Only detects largest UXO. Requires line of sight. Low industry familiarization. Effectiveness increases when used for wide area assessment in conjunction with other airborne technologies.	**Low:** Requires aircraft and an experienced pilot. Substantial data processing and management requirements. Available from few sources. Not implementable at the TOAR-FUDS as it requires ability to fly at extreme low altitudes, which vegetation at the site prevents.	**High** Aircraft and maintenance costs must be included. Processing costs are higher than other methods.	There are few multi/hyper spectral imagery providers.	Few have applied these technologies to the UXO problem.	**Low**
Airborne Synthetic Aperture Radar	**Low:** Detects both metallic and non-metallic objects. Only detects largest UXO. Requires line of sight. Medium industry familiarization. Effectiveness increases when used for wide area assessment in conjunction with other airborne technologies.	**Low:** Requires aircraft and an experienced pilot. Substantial data processing and management requirements. Available from few sources. Not implementable at the TOAR-FUDS as it requires ability to fly at extreme low altitudes, which vegetation at the site prevents.	**High** Aircraft and maintenance costs must be included. Processing costs are higher than other methods.		Few have applied these technologies to the UXO problem.	**Low**
Airborne Laser and Infrared Sensors	**Low:** Detects both metallic and non-metallic objects. Low industry familiarization. Effectiveness increases when used for wide area assessment in conjunction with other airborne technologies.	**Low:** Requires aircraft and an experienced pilot. Substantial data processing and management requirements. Available from few sources. Environmental concerns. Not implementable at the TOAR-FUDS as it requires ability to fly at extreme low altitudes, which vegetation at the site prevents.	**High** Aircraft and maintenance costs must be included. Processing costs are higher than other methods.		Few have applied these technologies to the UXO problem.	**Low**

Table 3-2 Positioning Technologies

Technology	Effectiveness	Implementability	Cost	Representative Systems	Notes	Viability at TOAR-FUDS
Differential Global Positioning System (DGPS)	**Low**: Very effective in open areas for both digital mapping and reacquiring anomalies. Very accurate when differentially corrected. Not effective in wooded areas or around large buildings. Commonly achieved accuracy is 20-50 cm, but degrades when minimum satellites are available. RTK GPS tested and proven effective only in open areas (not in wooded areas) during the GPO at the TOAR-FUDS.	**Low**: Easy to operate and setup. Requires trained operators. Available from a number of venders. Better systems are typically ruggedized and very durable. However, significant work time can be lost when insufficient satellites are available due to topography and tree canopy. Not implementable at the TOAR-FUDS due to topography and extensive tree canopy.	**Medium**: Requires rover and base station unit Survey Control points required for high accuracy results.	Leica GPS 1200 Trimble Model 5800 Thales Ashtech Series 6500 NovaTel RTK GPS	Recommended in open areas.	**Low to Medium** Technology not effective in wooded areas.
Robotic Total Station (RTS) (RTS is Laser ranging system)	**Medium to High**: Very effective in open areas for both digital mapping and reacquiring anomalies. Effective around buildings and sparse trees. Is being used in heavily wooded areas with moderate success. Commonly achieved accuracy is 5- 30cm (in wooded areas) to 2-10cm (in open areas), depending on operators' skill levels and accuracy of existing control points.	**Medium**: Easy to operate. Requires trained operators.	**Low**: Operates as a stand-alone unit. Typically requires survey control points but can be used in a relative coordinate system	Leica TRS 1100 Trimble Model 5600	Recommended around houses, in open areas and in moderately wooded areas. Typically used with time-domain electromagnetic induction metal detectors (like Geonics EM61-MK2).	**Medium to High** Technology not tested at TOAR-FUDS. Could work in moderately wooded areas, but usually used with detection systems like the Geonics EM61-MK2, which was not implementable due to terrain.
ArcSecond Constellation system (laser "fan"-type system)	**Medium**: Very effective in wooded and open areas. Limited in open areas due to range of transmitters. Extremely accurate positioning system. Commonly achieved accuracy is 0.5-1 cm	**Low**: Time consuming setup. Equipment not ruggedized. Lots of parts and connections. The ArcSecond Constellation is an emerging system and as such lacks a user-interface that is suitable for general implementation.	**Medium**: Requires some level of effort to setup and calibrate.	ArcSecond "In-door GPS" (Constellation)	Recommended in heavily wooded areas.	**Medium** Technology is recommended in heavily wooded areas, but is an emerging system with low implementability at this time.
Fiducial Method	**Medium - High**: Medium to high effectiveness when performed by experienced personnel. Low effectiveness when used by inexperienced personnel. Commonly achieved accuracy is 15-30cm in line and 20 –80 cm on laterals. Fiducial method tested and proven effective during the GPO at the TOAR-FUDS.	**Medium**: Easy to use, most applications require constant pace, most applications require detailed field notes. Can be used anywhere, with varying degrees of complexity in the operational setup. Fiducial method was difficult to implement during the RI at the TOAR-FUDS. Technicians found it difficult to maintain "lanes" due to topography and heavily wooded areas. Acoustic method proved easier to implement.	**Low - Medium**: Minimal direct costs associated with this method, however poor results may negatively impact costs associated with target resolution. Fiducial method requires more "back-end" data processing than some other methods.	NA	Requires very capable operators. Useful method if digital positioning systems are unavailable.	**Medium to High** Technology was tested and proven effective with atomic-vapor magnetometers during the GPO at the TOAR-FUDS, but was more difficult to implement than acoustic method and therefore not used during the RI.
Odometer Method	**Medium**: Medium to high effectiveness when performed by experienced personnel. Low effectiveness when used by inexperienced personnel. Commonly achieved accuracy is 15-30cm in line and 20 –80 cm on laterals	**Medium**: Setup and operation affected by terrain/environment. Requires detailed field notes and setup times can be lengthy. Similar to Fiducial Methods. Can be used anywhere, with varying degrees of complexity in the operational setup.	**Low**: Minimal direct costs associated with this method, however poor results may negatively impact costs associated with target resolution.	NA	Requires very capable operators. Useful method if digital positioning systems are unavailable.	**Medium** Technology not tested at TOAR-FUDS. Terrain could limit effectiveness and implementability.
Acoustic Method	**Medium - High**: Not very efficient in open areas due to substantial calibration and setup time. Effective in wooded areas although less accurate then other methods. Commonly achieved accuracy is 20-50 cm. Transponders have very limited range, on the order of 75 to 150 feet. USRADS was tested and proven effective during the GPO and the RI at the TOAR-FUDS.	**Medium**: Difficult to set up and setup requirements are complex. (However, more easily set up and used by trained personnel.) Not reliable. Very little available support. Negatively affected by environment.	**Medium**: Lengthy setup time can be reduced by using trained personnel. Requires more than one operator.	USRADS	Requires trained operators. Has been used extensively in wooded areas with success.	**Medium to High** Technology proven effective with atomic-vapor magnetometers at the TOAR-FUDS during the GPO and RI.

Table 3-2 Positioning Technologies (continued)

Technology	Effectiveness	Implementability	Cost	Representative Systems	Notes	Viability at TOAR-FUDS
Radio Frequency	**Medium**: Emerging RF systems have a medium to high effectiveness in open and wooded conditions. Mature RF systems are very effective for low-accuracy needs (1m to 3m accuracy).	**Low**: Emerging high-accuracy systems have unknown setup, operability and range parameters. Mature low-accuracy systems require trained operators, setup and calibration is lengthy, and they require existing control points to achieve highest accuracies. Ranges can be as high as 15 miles.	**Low**	High Accuracy: Unknown Low Accuracy: Motorola Del Norte Picodas	Still under development.	**Low**
Inertial Navigation	**Low**: Very time consuming with below average accuracy. Accuracy of 4-6cm (open area) is commonly achieved shortly after refreshing baseline data, but degrades quickly with time. Required frequency of refreshing baseline significantly reduces production rates.	**Low**: Difficult to operate, limited support.	**High**: Expensive to purchase or rent. Considerable time associated with refreshing baseline	Ranger	Still under development.	**Low**

and cost for the TOAR-FUDS. Only one detection technology listed in Table 3-1, the marine side-scan sonar, is designed for implementation in a marine environment. However, as noted in Table 3-1, the marine side-scan sonar only detects items on the surface of the water body floor, requires calm water, and vegetation can hinder acoustic signal propagation. As described in the RI report, approximately 25% of the TOAR-FUDS consist of lakes, streams, ponds, and wetland areas that are continually submerged, and adjacent areas that are intermittently submerged, depending on precipitation amounts and intensities. The lakes, ponds, and wetland areas include large vegetation mats and dense root growth. Therefore, technologies currently available for detection of UXO in marine environments would not be effective in the wet areas that exist at the TOAR-FUDS.

3.2.2.2 UXO Removal

Once a site has been surveyed by either visual or geophysical means, the removal of UXO can begin. UXO removal operations can take the form of a surface-only clearance, an intrusive (subsurface) clearance, or a combination of the two methods. The decision on the appropriate level of clearance operation is based on the nature and extent of the UXO hazards as well as the current land use and intended future land use of the site.

During a surface clearance operation, exposed UXO or suspected UXO items are identified during the detection phase. The UXO items are then inspected, identified, collected (if possible), and transported to a designated area for cataloging and eventual disposal. If it is determined during the UXO inspection that the risk of moving an item is unacceptable, then it may be necessary to destroy the UXO item in place.

Potential UXO items identified during a subsurface clearance operation by the geophysical survey or other detection methods require excavation for removal or detonation. Because the actual nature of the buried UXO item cannot be determined without it being uncovered, nonessential personnel evacuations are necessary within a predetermined minimum separation distance (MSD). The MSD is based on the munition with the greatest fragmentation distance (MGFD) that may be present within the sector. All non-essential personnel and the general public must be evacuated from and maintain their distance beyond the MSD during the intrusive operations. The MSD may be reduced if sufficient engineering controls are implemented.

Excavation of the potential UXO item takes place with either hand tools or mechanical equipment depending on the suspected depth of the object. Once the UXO item has been exposed, it is then inspected, identified, collected (if possible), and transported to a designated area for cataloging and disposal. If it is determined during the inspection that the item is UXO and the risk of moving the item is unacceptable, then it may be necessary to destroy the UXO item in place. In such cases the MSD is imposed on all personnel for intentional detonations. The MSD may be increased or decreased based on the actual identified UXO item. The MSD may also be reduced if appropriate engineering controls are applied. However, evacuations may be required if excavations are conducted close to inhabited areas and engineering controls cannot reduce the MSD to preclude the need to evacuate. Every possible option will be explored to minimize the potential evacuations with the exception of compromising public safety.

UXO removal technologies are described in Table 3-3 and screened against the three criteria of effectiveness, implementability, and cost for the TOAR-FUDS. The UXO removal technologies listed in Table 3-3, which is based on technical RI/FS guidance for MMRP sites distributed by CEHNC, have not been proven effective or implementable in wet environments such as those that exist in the wet areas at the TOAR-FUDS.

3.2.2.3 UXO Disposal

Disposal of recovered UXO can take one of three different forms: off-site demolition and disposal; remote, on-site demolition and disposal; and in-place demolition and disposal. The decision regarding which of these techniques to use is based on the risk involved in employing the disposal option, as determined by the specific area's characteristics and the nature of the UXO items recovered.

If an UXO item is recovered in close proximity to occupied buildings, it may not be possible to safely destroy the UXO item in place. In this instance, the UXO item can be moved to a remote part of the project site where demolition and disposal can safely take place. Situations where the UXO item cannot be moved due to fuzing or deteriorated condition are addressed on a case-by-case basis. For moveable UXO items, a countercharge can be used to destroy the UXO item. Engineering controls, such as sandbag mounds and sandbag walls over and around the UXO item, are often used to minimize the blast effects when an UXO item is destroyed in this manner.

Table 3-3 UXO Removal Technologies

Technology	Effectiveness	Implementability	Cost	Representative Systems	Notes	Viability at TOAR-FUDS
Hand Excavation	**Medium - High**: This is the industry standard for UXO removal. It can be very thorough and provides an excellent means of data collection.	**High**: Hand excavation can be accomplished in almost any terrain and climate. Limited only by the number of people available.	**Average**: As the standard by which all others are measured.	Probe, Trowel, Shovel, Pick Ax	Locally available and easily replaced tools	**High**
Mechanical excavation of individual anomalies	**Medium - High**: Used in conjunction with hand excavation when soil is too hard causing time delay during hand excavation. Method works well for the excavation of deep single anomalies or heavily contaminated areas.	**Low - High**: Equipment can be rented almost anywhere, are easy to operate, and allow excavation of anomalies in hard soil and to clear large areas with substantial metal contamination. Access to site may be limited in certain areas by terrain (trees, boulders/rocks). Mechanical excavation is not appropriate for items located on or near the surface because safety standards allow for Mechanical excavation only to within 12 inches of a suspected UXO item.	**Low**: In hard soil this method has a lower cost than that of having the single anomalies hand excavated.	Tracked Mini-Excavator, wheeled backhoe, etc. Multiple manufacturers	Easy to rent and operate	**High** For subsurface anomalies deeper than 12 inches. **Low** For surface anomalies or subsurface anomalies less within 12 inches of ground surface.
Mass Excavation and Sifting	**High**: Process work very well in heavily contaminated areas. Can separate several different sizes of material allowing for large quantities of soil to be returned with minimal screening for UXO.	**Low**: Earth moving equipment is readily available; however, armoring is not as widely available. Equipment is harder to maintain and may require trained heavy equipment operators. Not feasible for large explosively-configured munitions. Not feasible for heavily wooded areas with numerous ecosystems that must be protected.	**High**: Earth moving equipment is expensive to rent and insure and has the added expense of high maintenance cost as well.	**Earth Moving Equipment**: Many brands of heavy earth moving equipment that include excavators, off road dump trucks, and front-end loaders. **Sifting Equipment**: Trommel, Shaker, Rotary Screen from varying manufacturers.	Can be rented, armor installed, and delivered almost anywhere. Significant maintenance costs.	**Low** Technology is effective, but ecosystems at TOAR-FUDS must be protected and technology is costly.
Magnetically Assisted Removal	**Low**: Primarily used in conjunction with mass excavation and sifting operations. Can help remove metal from separated soils, but does not work well enough to eliminate the need to inspect the smaller size soil spoils. Magnetic systems are also potentially useful to help with surface clearance of frag and surface debris.	**High**: Magnetic rollers are easily obtained from the sifting equipment distributors and are designed to work with their equipment.	**Low**: This method adds very little cost to the already expensive sifting operation.	Magnetic rollers or Magnetic pick ups are available from many manufacturers of the sifting equipment noted above.	Installed by sifting equipment owners.	**Low** Primarily used in conjunction with mass excavation and sifting operations, which are not feasible for the TOAR-FUDS.
Remotely Operated Removal Equipment	**Low**: Remotely operated equipment reduces productivity and capability of the equipment. Method is not widely used and is not yet proven to be an efficient means of UXO removal.	**Low**: Uses earth moving equipment, both mini-excavator type and heavier off road earth moving equipment. Machinery is rigged with hydraulic or electrical controls to be operated remotely.	**High**: Has a combined cost of the base equipment plus the remote operating equipment and an operator. Remote operation protects the operator, but can create high equipment damage costs.	Many tracked excavators, dozers, loaders and other equipment types have been outfitted with robotic remote controls.	EOD robots are almost exclusively used for military and law enforcement reconnaissance and render-safe operations. They were not evaluated for UXO applications.	**Low**

Alternatively, a UXO item may be blown-in-place (BIP). This technique is typically employed when the risk of moving the UXO item to a remote location is unacceptable. When employing this technique, procedures similar to those described above are used that will detonate the UXO item. When this technique is employed, engineering controls are again often used to minimize the blast effects. All UXO disposal technologies generate a waste stream, which must be addressed when determining which technologies are most viable. The waste streams generated by UXO disposal technologies include munitions constituents and/or MD. If the waste generated includes munitions constituents, then the waste stream may need to undergo additional treatment prior to final disposal. If the waste generated includes only MD, then additional treatment may not be necessary.

UXO disposal technologies are described in Table 3-4 and screened against the three criteria of effectiveness, implementability, and cost for the TOAR-FUDS. Treatment technologies for the waste streams generated by UXO disposal technologies are described in Table 3-5 and screened against the three criteria of effectiveness, implementability, and cost for the TOAR-FUDS. Tables 3-4 and 3-5 are based on technical RI/FS guidance for MMRP sites distributed by CEHNC.

3.2.3 Viable Technologies for the TOAR-FUDS

The technologies deemed highly viable in Tables 3-1 to 3-5 for the TOAR-FUDS are summarized in Table 3-6 and will be included in the development of remedial alternatives in Section 4.

As noted in subsections 3.2.2.1 and 3.2.2.2, approximately 25% of the TOAR-FUDS consist of lakes, streams, ponds, and wetland areas that are continually submerged, and adjacent areas that are intermittently submerged, depending on precipitation amounts and intensities. The lakes, ponds, and wetland areas include large vegetation mats and dense root growth. Therefore, technologies currently available for UXO detection and removal would not be effective or implementable in the wet environments that exist at the TOAR-FUDS. Wetlands at the TOAR-FUDS will be considered in the detailed evaluation of remedial alternatives in Section 5.

Table 3-4 UXO Disposal Technologies

Technology	Effectiveness	Implementability	Cost	Representative Systems	Notes	Viability at TOAR-FUDS
Render Safe Procedures (RSP)	**Low** Hazardous components may remain intact after procedure. Some procedures may expose hazardous materials inadvertently or intentionally. Lower probability of success compared to other methods. Presents significant danger to performer. No MC or MD-related waste stream generated.	**Low** Significant personnel exposure in implementation. Specialized tools and equipment commonly are required.	**Medium to High** Manpower intensive, specialized tools and equipment.	Manual Disassembly Mechanical Disassembly Explosive Dearmer Cryofracture	RSP not allowed in execution of UXO Remediation by UXO Technicians.	**Low**
Blow in Place (BIP)	**Medium to High** Each UXO item is individually destroyed with subsequent results individually verified (QC/QA). BIP yields unconfined releases of MC and MD, which can be restricted using engineering controls.	**Medium to High** Field-proven techniques, transportable tools and equipment, suited to most UXO environments. Public exposure can limit viability of this option. Engineering controls can further improve implementation.	**Medium to High** Manpower intensive. Costs increase in areas of higher population densities or where public access must be monitored/controlled.	Electric demolition procedures non-electric demolition procedures	Disposition of resultant waste streams must be addressed in BIP operations planning.	**High**
Consolidate and Blow (C&B)	**Medium to High** Techniques recently developed and refined in Iraq are providing documented successes. Use of donor munitions also proving effective. Limited in use to munitions that are “acceptable to move”. C&B yields unconfined releases of MC and MD, which can be restricted using engineering controls.	**Medium** Generally employs same techniques, tools and equipment as BIP. Requires larger area and greater controls. Most engineering controls not completely effective/applicable for these operations.	**Medium** Manpower intensive, may require materials handling equipment (MHE) for large scale operations.	Electric demolition procedures non-electric demolition procedures forklifts and cranes	Disposition of resultant waste streams must be addressed. Increased areas require additional access and safety considerations.	**High**
Contained Detonation Chambers (CDCs) – Stationary	**Medium to High** CDCs successfully contain hazardous components. Current literature reviewed shows containment up to 35 lbs (assume net explosive weight [NEW]). Commonly used for fuzes and smaller explosive components. Limited in use to munitions that are “acceptable to move”. CDCs yield confined releases of MC and MD.	**Low - Medium** Stationary facilities typically must meet regulatory and construction standard for permanent/semi-permanent waste disposal facilities. Service life and maintenance are issues. Requires additional handling of UXO. Flashing furnaces have low feed rates due to safety concerns. Produces additional hazardous waste streams.	**High** Siting and construction required. Low feed rates = more hours on site. Significant requirements for maintenance of system.	Typically designed on case-by-case basis.	System cleaning and maintenance usually requires personal protective equipment (PPE) and worker training. Probable permitting issues with employment of technology.	**Low to Medium**
Contained Detonation Chambers (CDCs) - Mobile	**Medium** CDCs successfully contain hazardous components. Current literature reviewed shows containment up to 35 lbs (assume NEW). Commonly used for fuzes and smaller explosive component, not for larger artillery like 155-mm. Limited in use to munitions that are “acceptable to move”. CDCs yield confined releases of MC and MD.	**Low** Designed to be deployed at the project site. Greatly reduced footprint compared to stationary facilities. Service life and maintenance are issues. Requires substantial additional handling and transport of UXO. Requires UXO be safe to move. Flashing furnaces have low feed rates due to safety concerns. Produces additional hazardous waste streams.	**Medium - High** Possible Construction required (e.g., berms and pads). Low feed rates = more hours on site. Significant requirements for maintenance of system.	Donovan Blast Chamber Kobe Blast Chamber	System cleaning and maintenance usually requires PPE and worker training. Probable permitting issues with employment of technology.	**Low to Medium**
Laser Initiation	**Medium** Still in development, though currently deployed in Iraq for testing. Tests show positive results for 81mm and below, with reported success on munitions up to 155mm. Produces low-order type effect; subsequent debris still requires disposition. Laser initiation yields unconfined releases of MC and MD, which can be restricted using engineering controls.	**Low** UXO targets must be exposed/on surface for attack by directed beam. GATOR Laser System (Diode Laser Neutralization via Fiber-Optic Delivered Energy) does not require line-of-sight within approximately 100m. GATOR system does require approach and placement of fiber-optic cable at appropriate position of UXO. Laser systems still addressing power, configuration, transportability and logistics issues.	**Medium to Low** Greatly reduced manpower; added equipment, transportability and logistics concerns; no explosives required by system	ZEUS-HLONS GATOR LASER	Offers added safety through significant standoff (up to 300m). (note: acceptable safety standoffs must be evaluated for specific UXO and scenarios). ZEUS prototype deployed/employed in Afghanistan (2003).	**Low**

Table 3-5 Waste Stream Treatment Technologies

Technology	Effectiveness	Implementability	Cost	Representative Systems	Notes	Viability at TOAR-FUDS
Chemical Decontamination	**Low to Medium** Great variance in chemicals required to decontaminate various MEC (e.g., propellants, pyrotechnics, explosives). Difficult to test for effectiveness of many methods. May generate additional waste streams (some hazardous).	**Low to Medium** Requires containment of multiple hazardous materials (e.g., MEC and solvents). May require emissions controls. Worker training and PPE typically required.	**Medium to High** Specialized manpower, containment requirements, additional waste stream processing	Various solvents (acetone, acids); water		**Low**
Shredders and Crushers	**Medium** Renders small arms, fuzes and other components inoperable. Residue will typically still require additional treatment to achieve higher decontamination levels.	**Low to Medium** Typically stationary facilities. Service life and very high maintenance are expected. Requires additional handling of UXO.	**Medium to High** Specialized equipment and operators. High maintenance. Additional waste stream processing.	Shred Tech ST-100H Roll-Off (vehicle mounted)	Disposition of resultant waste streams must be addressed.	**Low to Medium**
Flashing Furnaces	**High** Furnaces are designed to contain hazardous components. Methods are proven means of attaining high degrees (5X) of decontamination. Commonly used to destroy and decontaminate fuzes and smaller explosive components.	**Medium** Typically stationary facilities. Service life and maintenance are issues. Requires additional handling of UXO. Flashing furnaces have low feed rates due to safety concerns. Produces additional hazardous waste streams	**High** Possible construction required. Low feed rates = more hours on site. Maintenance of system.	Rotary kiln incinerator Explosive waste incinerator (EWI) Transportable flashing furnace	System cleaning and maintenance usually requires PPE and worker training. May require permit to deploy technology.	**Low to Medium**
Recycling	**High** Very effective for MD and non-MEC-related scrap. Not appropriate for munitions constituents that still pose an explosive hazard.	**High** Easily implemented if there is a local metal recycler. Implemented at TOAR-FUDS during RI.	**Low to Medium**			**High**

Table 3-6 Viable Technologies for the TOAR-FUDS

UXO Detection		UXO Removal	UXO Disposal	
Geophysical Detection	**Positioning**		**Disposal**	**Waste Stream Treatment**
• Digital (DGM) • Analog (M&D)	• Robotic Total Station (with DGM) • Fiducial Method (with DGM) • Acoustic Method (with DGM) • Conventional Survey (with M&D)	• Hand excavation • Mechanical excavation to within 12 inches of anomalies, followed by hand excavation (only for anomalies deeper than 12 inches)	• A combination of the following methods, based on UXO item evaluation in the field by qualified UXO technicians: – Blow in Place – Consolidate and Blow	• MD and non-MEC-related material recovered from UXO disposal will be sent to a local metals recycler. • Munitions constituents recovered from UXO disposal will be addressed as appropriate, and treated if necessary, using one of the following methods: – Chemical decontamination – Shredding or crushing – Flash furnace

4. DEVELOPMENT AND SCREENING OF ALTERNATIVES

This section combines the technologies and general remedial actions deemed highly viable for use at the TOAR-FUDS in Section 3 to form remedial alternatives. The remedial alternatives developed in this section, screened, and deemed highly viable for use at the TOAR-FUDS will be evaluated against the NCP criteria in the detailed analysis in Section 5.

4.1 DEVELOPMENT OF ALTERNATIVES

Remedial alternatives for the TOAR-FUDS are described in the following subsections. All alternatives are summarized in Table 4-1, located at the end of subection 4.1.

It should be noted that CERCLA requires the review of remedial actions no less than every five years to assure that human health and the environment are being protected. Recurring reviews for UXO remedial actions determine if a remedial action continues to minimize explosives safety risks and continues to be protective of human health, safety, and the environment, and provide an opportunity to assess the applicability of new technology for addressing previous technical impracticability determinations. Recurring reviews will be completed by USACE and include the following general steps:

- Prepare Recurring Review Plan.
- Establish project delivery team and begin community involvement activities.
- Review existing documentation.
- Identify/review new information and current site conditions.
- Prepare preliminary Site Analysis and Work Plan.
- Conduct site visit.
- Prepare Recurring Review Report.

4.1.1 Alternative 1 – No Action

Alternative 1 is for the government to take no action in regards to locating, removing, and disposing of any potential UXO present within an AOC at the TOAR-FUDS. In addition, no

public awareness or education training would be initiated with regards to the risk of UXO. The No Action alternative assumes continued land use of the sector in its present state. If the potential exposure and hazards associated with the AOC are compatible with current and future development in the area, as well as the UXO response action objectives, then No Action may be warranted. It is important to note that the government will respond to any future UXO discovery at the TOAR-FUDS. The No Action alternative is a potential candidate for each of the AOCs.

4.1.2 Alternative 2 – Land Use Controls (LUCs)

Aside from conventional UXO remedial actions, risks related to potential UXO hazards may be managed through LUC alternatives consisting of various access control and/or public awareness components. The implementation of LUCs would provide a means for the landowners and their representatives to coordinate in an effort to reduce UXO exposure risk through behavior modification. The LUCs alternative can be used in combination with other UXO remedial actions or in cases where it may not be possible or practical to physically clear UXO from the AOC. Successful implementation of LUCs is contingent on the cooperation and active participation of the existing powers and authorities of the property owners, as well as other government agencies to protect the public from UXO risks. The remedial design will specify steps and controls to be put in place that will ensure the LUCs are maintained, thus ensuring long-term effectiveness and permanence.

In general, all organizations interviewed during the RI, including DCNR and PGC, expressed an interest/willingness to participate in LUCs. LUCs recommended for the TOAR-FUDS are presented in Section 8 of the RI report, and include the following:

- Signs.
- Notification during permitting.
- Brochures/fact sheets.
- Newspaper articles and interviews.
- Information packages to public officials and emergency management agencies.
- Visual and audio media.

- Classroom education.
- Internet website.
- Technical Review Committee (TRC).
- Reverse 911 system.

Construction support would also classify as a LUC, and would be provided by USACE to ensure the safety of workers and the public in the event that UXO items are discovered during any future construction activities at the TOAR-FUDS in areas that have not been cleared of UXO.

All LUCs considered for the TOAR-FUDS are described and evaluated in the Institutional Analysis Report presented in Appendix N of the RI report.

4.1.3 UXO Removal Alternatives

The general remedial action of UXO removal has been broken down into three remedial alternatives for evaluation:

- **Surface removal of UXO** – Removal of UXO detected on the ground surface and breaching the ground surface.
- **Removal of UXO to one foot** – Removal of UXO detected on the ground surface and removal of UXO with any part within one foot of the ground surface.
- **Removal of UXO to detection depth** – Removal of all UXO detected. Depth of detection varies based on depth of UXO at the site and detection technology used.

All UXO removal alternatives will include a combination of disposal methods, recycling and/or waste stream treatment, as well as LUCs.

4.1.3.1 Alternative 3 – Surface Removal of UXO with LUCs

Surface removal of UXO includes removal of UXO detected on the ground surface and breaching the ground surface using visual observation and analog instrument assistance. The following general tasks would be included as part of Alternative 3:

- Mobilization.
- Survey/positioning.

- Brush clearing and grubbing.
- UXO detection.
- UXO removal.
- UXO disposal.
- Scrap disposal.
- Demobilization.

Waste streams generated from UXO disposal will be addressed as appropriate, using either recycling or treatment. LUCs will be implemented as described in Alternative 2 in subsection 4.1.2.

4.1.3.2 Alternative 4 – Removal of UXO to One Foot with LUCs

Removal of UXO to one foot includes removal of UXO detected on the ground surface and removal of UXO with any part within one foot of the ground surface. A detection depth of one foot was chosen as a general remedial action because 95% of the UXO items recovered at the TOAR-FUDS during the RI were located within one foot of the ground surface.

4.1.3.2.1 Removal of UXO to One Foot Using Digital Detection Methods

The following general tasks would be included as part of Alternative 4 using digital detection methods:

- Mobilization.
- Survey/positioning.
- Brush clearing and grubbing.
- Geophysical mapping.
- Geophysical data analysis.
- Anomaly reacquisition.
- UXO removal.
- UXO disposal.

- Scrap disposal.
- Demobilization.

Waste streams generated from UXO disposal will be addressed as appropriate, using either recycling or treatment. LUCs will be implemented as described in Alternative 2 in subsection 4.1.2.

4.1.3.2.2 Removal of UXO to One Foot Using Analog Detection Methods

The detection and positioning techniques and disposal methods described above for Alternative 3 are also used for Alternative 4. However, in Alternative 4, in addition to surface anomalies, subsurface anomalies detected with any part at a minimum depth of one foot will be investigated and excavated by hand. LUCs will be implemented as described in Alternative 2 in subsection 4.1.2.

4.1.3.3 Alternative 5 – Removal of UXO to Detection Depth with LUCs

Removal of UXO to detection depth includes removal of all UXO detected. Depth of detection varies based on depth of UXO at the site and detection technology used.

4.1.3.3.1 Removal of UXO to Detection Depth Using Digital Detection Methods

The detection and positioning techniques and disposal methods described above for Alternative 4 using digital detection methods are also used for Alternative 5. However, in Alternative 5, anomalies that are detected deeper than one foot bgs may be excavated using mechanical equipment where possible. In accordance with USACE safety procedures, a backhoe can only be used to excavate within 12 inches of the detected anomaly, then hand excavation must be used to remove the item. LUCs will be implemented as described in Alternative 2 in subsection 4.1.2.

4.1.3.3.2 Removal of UXO to Detection Depth Using Analog Detection Methods

The detection and positioning techniques and disposal methods described above for Alternatives 3 and 4 using analog detection methods are also used for Alternative 5. However, in Alternative 5, anomalies that are detected deeper than one foot bgs may be excavated using mechanical equipment where possible. In accordance with USACE safety procedures, a backhoe can only be

used to excavate within 12 inches of the detected anomaly, then hand excavation must be used to remove the item.

LUCs will be implemented as described in Alternative 2 in subsection 4.1.2.

4.2 SCREENING OF ALTERNATIVES

The technologies combined to form the remedial alternatives summarized in Table 4-1 have already been screened against the three criteria of effectiveness, implementability, and cost, and deemed highly viable at the TOAR-FUDS in Section 3. Therefore, all five (5) remedial alternatives will be evaluated in the detailed analysis in Section 5.

In Section 5, remedial alternatives for AOCs with the same risk associated with UXO, as determined in the RI report and summarized in Table 1-1, are combined to minimize redundancy in the detailed analysis. Therefore, remedial alternatives for AOCs with high risk (TOAR-1, TOAR-2, TOAR-3, TOAR-4, and TOAR-5) will be analyzed together, and remedial alternatives for AOCs with low or low-moderate risk (TOAR-6, TOAR-7, TOAR-8 and TOAR-9) will be analyzed together.

However, the proposed removal activities described in Table 4-1 are not necessarily viable for AOCs with low or low-moderate risk. Therefore, the three proposed removal activities (Alternatives 3, 4, and 5) are screened against the three criteria of effectiveness, implementability, and cost in Table 4-2 to determine their viability for AOCs with low or low-moderate risk. As shown in Table 4-2, removal activities are not viable in AOCs with low or low-moderate risk, and therefore Alternatives 3, 4, and 5 will not be evaluated for AOCs with low risk in Section 5.

Table 4-1 Remedial Alternatives to be Evaluated for the TOAR-FUDS

Altern. No.	General Remedial Action	Processes	Access Control/ Public Education	UXO Detection		UXO Removal	UXO Disposal	
				Detection	Positioning		Disposal	Waste Stream Treatment
1	No DOD Action	NA	NA	NA	NA	NA	NA	NA
2	Land Use Controls	Access Control, Public Education	Additional Signage, Permitting, Audio/Visual, Update Website, TRC, Reverse 911, Construction Support	NA	NA	NA	NA	NA
3	Surface Removal	Detection, Removal, Disposal	NA	Visual and Analog (M&D)	RTS, Fiducial Method, or Acoustic Method (with DGM) or Conventional Survey (with M&D)	Hand excavation	BIP and C&B	Recycling or Treatment
	Land Use Controls	Access Control, Public Education	(See Alternative 2 for description)	NA	NA	NA	NA	NA
4	Removal to one foot	Detection, Removal, Disposal	NA	Digital (DGM) or Analog (M&D)	RTS, Fiducial Method, or Acoustic Method (with DGM) or Conventional Survey (with M&D)	Hand excavation	BIP and C&B	Recycling or Treatment
	Land Use Controls	Access Control, Public Education	(See Alternative 2 for description)	NA	NA	NA	NA	NA
5	Removal to detection depth	Detection, Removal, Disposal	NA	Digital (DGM) or Analog (M&D)	RTS, Fiducial Method, or Acoustic Method (with DGM) or Conventional Survey (with M&D)	Mechanical excavation to within 12 inches of anomalies, followed by hand excavation	BIP and C&B	Recycling or Treatment
	Land Use Controls	Access Control, Public Education	(See Alternative 2 for description)	NA	NA	NA	NA	NA

NA = Not applicable.

Table 4-2 Screening of Removal Activities for AOCs with Low or Low-Moderate Risk

Remedial Alternative	Effectiveness	Implementability	Cost	Viability at TOAR-FUDS
3 Surface Removal with LUCs	**Lowest:** In AOCs with low risk, UXO has not been found to date. Alternative 3 would not be effective in reducing the presence of UXO further. In AOCs with low-moderate risk, UXO has been found in close proximity to impact areas, but in very low densities. Alternative 3 would be minimally effective in reducing UXO densities further.	**Highest:** Alternative 3 is technically and administratively feasible at the TOAR-FUDS. Surface and subsurface items have been detected, removed, and disposed of successfully during previous investigation at the TOAR-FUDS.	**High:** Alternative 3 would require a large amount of manpower and specialized equipment.	**Low** Based on the low effectiveness and high cost of Alternative 3, a surface removal is not viable for AOCs with low or low-moderate risk at the TOAR-FUDS.
4 Removal to one foot with LUCs	**Lower:** In AOCs with low risk, UXO has not been found to date. Alternative 4 would not be effective in reducing the presence of UXO further. In AOCs with low-moderate risk, UXO has been found in close proximity to impact areas, but in very low densities. Alternative 4 would be minimally effective in reducing UXO densities further.	**Higher:** Alternative 4 is technically and administratively feasible at the TOAR-FUDS. Surface and subsurface items have been detected, removed, and disposed of successfully during previous investigation at the TOAR-FUDS.	**Higher:** Alternative 4 would require a large amount of manpower and specialized equipment.	**Lower** Based on the low effectiveness and high cost of Alternative 4, a surface removal is not viable for AOCs with low or low-moderate risk at the TOAR-FUDS.
5 Removal to detection depth with LUCs	**Low:** In AOCs with low risk, UXO has not been found to date. Alternative 5 would not be effective in reducing the presence of UXO further. In AOCs with low-moderate risk, UXO has been found in close proximity to impact areas, but in very low densities. Alternative 5 would be minimally effective in reducing UXO densities further.	**High:** Alternative 5 is technically and administratively feasible at the TOAR-FUDS. Surface and subsurface items have been detected, removed, and disposed of successfully during previous investigation at the TOAR-FUDS.	**Highest:** Alternative 5 would require a large amount of manpower and specialized equipment.	**Lowest** Based on the low effectiveness and high cost of Alternative 5, a surface removal is not viable for AOCs with low or low-moderate risk at the TOAR-FUDS.

5. DETAILED ANALYSIS OF ALTERNATIVES

The detailed analysis of alternatives consists of the analysis and presentation of the relevant information needed to allow decision makers to select a site remedy, not the decision making process itself. During the detailed analysis, each alternative is assessed against the NCP evaluation criteria described in subsection 5.1 for the AOCs at the TOAR-FUDS. The results of the detailed analysis are arrayed to compare the alternatives and identify their strengths and weaknesses relative to one another. This approach to analyzing alternatives is designed to provide decision makers with sufficient information to adequately compare the alternatives, select an appropriate remedy for each AOC, and demonstrate satisfaction of the CERCLA remedy selection requirements in the Decision Document.

5.1 EVALUATION CRITERIA

Evaluation criteria are described in the NCP, Section 300.430. The criteria were developed to address the CERCLA requirements and considerations, and to address the additional technical and policy considerations that have proven to be important for selecting among remedial alternatives. These evaluation criteria serve as the basis for conducting the detailed analyses during the FS and for subsequently selecting an appropriate remedial action. The evaluation criteria with the associated statutory considerations are described below.

The NCP calls the two factors described below "threshold factors" because each alternative must meet the two criteria.

1. **Overall protectiveness of human health and the environment –** Determines whether an alternative achieves the remedial action objectives by eliminating, reducing, or controlling threats to public health and the environment through land use controls, engineering controls, or treatment. The evaluation is based on the three risk factors used in the OE RIA presented in Section 7 of the RI report: UXO factors, site characteristics factors, and human factors. An emphasis is placed on effectiveness in terms of worker safety issues during remedial actions, and post-remedial action for local residents and workers based on future land use.
2. **Compliance with ARARs and TBCs** – Evaluates whether the alternative meets Federal and State environmental statutes, regulations, and other requirements that pertain to the site, or whether a waiver is justified. ARARs and TBCs are summarized in Section 2.

The five “balancing factors” described below are weighed against each other to determine which remedies are cost effective and are "permanent" to the maximum extent practicable.

3. **Long-term effectiveness and permanence –** Considers the ability of an alternative to maintain protection of human health and the environment over time. For MEC sites, this will typically fall into categories associated with land use controls that include access controls (fences, signage, etc.) and land use controls (education programs, land use restrictions, deed notifications, etc). The long-term effectiveness and permanence of land use controls will need to take into account the administrative feasibility of maintaining the land use controls and the potential risk/hazard should they fail, as well as mechanisms like the CERCLA Five Year Review process to evaluate on a periodic basis the long-term effectiveness and permanence, as well as protectiveness.

4. **Reduction of toxicity, mobility, or volume (TMV) of contaminants through treatment –** Evaluates an alternative's use of treatment to reduce the harmful effects of principal contaminants, their ability to move in the environment, and the amount of contamination present. For MEC sites where the treatment options are generally limited to certain disposal options (blow in place, consolidated shot, containerized version of these) the destruction of the MEC should be considered as constituting treatment that reduces the amount of MEC found. This is analogous to reduction in volume. Mobility in the context of hazardous, toxic, and radioactive waste (HTRW) treatment where a hazardous substance is immobilized does not have a direct analogy for MEC. Mobility may be considered a function of the ease of moving a MEC item, as well as physical processes (e.g. erosion, frost heave, flooding of surrounding soil or sediment, tidal currents) that may affect movement of MEC from its original depth or location. To the extent that MEC is detected, recovered, and disposed of, its ability to move is reduced. MEC remaining after a removal activity would maintain its ability to move, based on the physical processes described above, and should be accounted for.

5. **Short-term effectiveness –** Considers the length of time needed to implement an alternative and the risks the alternative poses to workers, residents, and the environment during implementation. In addition, for MEC, safety considerations will include an evaluation of what is available from an administrative standpoint (e.g. access) and what is available from a technical standpoint (e.g. set backs – are buildings too close for BIP; what will it take to bring the correct resources to the site to mitigate a BIP, etc.).

6. **Implementability –** Considers the technical and administrative feasibility of implementing the alternative, including factors such as the relative availability of goods and services.

7. **Cost –** Includes estimated capital and annual operations and maintenance (O&M) costs, as well as present worth cost. Present worth cost is the total cost of an alternative over time in terms of today's dollar value. Cost estimates are expected to be accurate within a range of +50 to -30%.

The last two criteria, the "modifying factors," are usually evaluated following comment on the FS, and should be completed after the proposed plan and public comment period on that Plan in the Decision Document or Record of Decision:

8. **Regulatory agency acceptance –** Considers whether the state (PADEP) and EPA Region III agree with the Army's analyses and recommendations, as described in the RI/FS.
9. **Community acceptance –** Considers whether the local community agrees with the Army's analyses and preferred alternative. Comments received on the RI/FS are an important indicator of community acceptance.

However, regulatory agency acceptance is addressed preliminarily in this FS based on input received from PADEP and EPA throughout the project.

5.2 INDIVIDUAL ANALYSIS OF ALTERNATIVES

As discussed in Section 4, remedial alternatives for AOCs with similar risk, as determined in the RI report and summarized in Table 1-1, have been combined to minimize redundancy in this detailed analysis. Therefore, remedial alternatives for AOCs with high risk (TOAR-1, TOAR-2, TOAR-3, TOAR-4, and TOAR-5) will be analyzed together, and remedial alternatives for AOCs with low or low-moderate risk (TOAR-6, TOAR-7, TOAR-8 and TOAR-9) will be analyzed together. All remedial alternatives are described in subsection 4.1 and summarized in Table 4-1.

5.2.1 AOCs with Low or Low-Moderate Risk

Remedial alternatives are evaluated against the NCP criteria for AOCs with low or low-moderate risk in Tables 5-1 and 5-2. Remedial alternatives evaluated for AOCs with low or low-moderate risk include the following:

- Alternative 1 – No Action.
- Alternative 2 – Land Use Controls (LUCs).

5.2.2 AOCs with High Risk

Remedial alternatives are evaluated against the NCP criteria for AOCs with high risk in Tables 5-3 to 5-7. Remedial alternatives evaluated for AOCs with high risk include the following:

Table 5-1 Evaluation of Alternative 1 for AOCs with Low or Low-Moderate Risk

Alternative	Evaluation	Overall Protectiveness of Human Health and the Environment	Compliance with ARARs and TBCs	Long-Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, or Volume (TMV) of Contaminants Through Treatment	Short-Term Effectiveness	Implementability	Cost[1]	Regulatory Agency Acceptance[2]
1 No Action	General	AOCs TOAR-6, TOAR-7, TOAR-8, and TOAR-9 at the TOAR-FUDS were evaluated to have low or low-moderate risk in Section 7 of the RI report. UXO densities in these AOCs ranged from 0 to 0.33 UXO/acre. Therefore, UXO is present at low densities in some areas. The No Action alternative would not address this risk and would therefore not be protective of human health. The No Action alternative would be protective of the environment because no clearing, grubbing, or excavation would be required.	There are no location- or action-specific ARARs associated with the No Action alternative because there are no active remedial actions associated with this alternative.	The magnitude of risk is not expected to reduce significantly over the long term based on current and intended future land use. The No Action alternative requires no technical components and poses no uncertainties regarding its performance. Site reviews would be conducted once every 5 years as required by CERCLA to assess the site condition and the degree of protectiveness to human health and the environment.	No reduction of UXO volume or mobility due to frost heave or erosion would take place under the Alternative 1.	There would be no additional risk to the community or workers because there are no construction or operation activities associated with this alternative.	Implementation of this alternative poses no technical difficulties. This alternative would be administratively feasible because it requires minimal contact or coordination with agencies to implement.	$94,575	Based on concerns for public safety and the environment, PADEP and EPA Region III would prefer a positive remedial action and would accept the most protective alternative first, down to the least protective alternative. Therefore, Alternative 1 would not be acceptable.
	Wetlands Considerations[3]	As described in Section 7 of the RI, the risk to human health associated with UXO in the wetlands at the TOAR-FUDS is low due to a lack of accessibility and activity. Therefore, any remedial alternative in the wetlands would only reduce the risk to human health slightly, from low to lower. The No Action alternative would be protective of the environment in the wetlands because no clearing, grubbing, or excavation would be required.	Alternative 1 would be protective of the environment in the wetlands, and therefore would be in compliance with ARARs that protect wetlands.	The magnitude of risk in the wetlands is not expected to increase or decrease significantly over the long term based on intended future land use.	No reduction of UXO volume or mobility due to frost heave or erosion in the wetlands would take place under the Alternative 1.	There would be no additional risk to the community or workers because there are no construction or operation activities in the wetlands associated with this alternative.	Implementation of this alternative poses no technical difficulties. This alternative would be administratively feasible because it requires minimal contact or coordination with agencies to implement.	The presence of wetlands does not impact costs for Alternative 1.	

[1]The cost shown represents the total present-worth cost to perform recurring reviews every five years for 30 years for Alternative 1 in any AOC with low or low-moderate risk. The cost to perform Alternative 1 for any AOC is summarized in Table 5-8. Detailed cost estimates for Alternative1 for each AOC are provided in Appendix B.

[2]Regulatory acceptance and community acceptance are typically evaluated during the Proposed Plan. However, because this project was led by PADEP, with involvement from EPA, a preliminary regulatory acceptance discussion has been included to capture regulator involvement and input during the RI/FS.

[3]Approximately 25% of the TOAR-FUDS is covered by wet areas, including wetlands. This discussion addresses wetlands considerations relative to the remedial alternative.

Table 5-2 Evaluation of Alternative 2 for AOCs with Low or Low-Moderate Risk

Alternative	Evaluation	Overall Protectiveness of Human Health and the Environment	Compliance with ARARs and TBCs	Long-Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, or Volume (TMV) of Contaminants Through Treatment	Short-Term Effectiveness	Implementability	Cost[1]	Regulatory Agency Acceptance[2]
2 Land Use Controls (LUCs)	General	AOCs TOAR-6, TOAR-7, TOAR-8, and TOAR-9 at the TOAR-FUDS were evaluated to have low or low-moderate risk in Section 7 of the RI report. UXO densities in these AOCs ranged from 0 to 0.33 UXO/acre. Therefore, UXO is present at low densities in some areas. The components of LUC that are recommended would raise public awareness and modify public behavior related to the activities they perform at the TOAR-FUDS, which would result in increased protection for human health. Also, the LUCs alternative would be protective of the environment because no clearing, grubbing, or excavation would be required.	The LUCs that are recommended in the RI would be implemented to comply with all ARARs and TBCs.	Alternative 2 is contingent on the cooperation and active participation of the existing powers and authorities of government agencies. The remedial design will specify steps and controls to be put in place that will ensure the LUCs are maintained, thus ensuring long-term effectiveness and permanence. The components of LUCs that are recommended, as described in subsection 4.1.2, require operation and maintenance of warning signs, printed media, audio and visual media, websites, and a reverse 911 system. Site reviews would be conducted once every 5 years as required by CERCLA to assess the site condition and the degree of protectiveness to human health and the environment.	No reduction of UXO volume or mobility due to frost heave or erosion would take place under Alternative 2.	There may be a slight increase in risk to workers, depending on where additional signs were posted. Otherwise, there would be no additional risk to the community or workers because there are no other construction or operation activities associated with this alternative.	Most of the components recommended in the LUC alternative can be easily implemented because there no technical difficulties associated with this alternative and the materials and services needed to implement this alternative are available. The implementation of a reverse 911 system may require additional technical and operational expertise. Operation and maintenance of warning signs, audio and visual media, and websites can be performed easily.	$626,383	Based on concerns for public safety and the environment, PADEP and EPA Region III would prefer a positive remedial action and would accept the most protective alternative first, down to the least protective alternative.
	Wetlands Considerations[3]	As described in Section 7 of the RI, the risk to human health associated with UXO in the wetlands at the TOAR-FUDS is low due to a lack of accessibility and activity. Therefore, any remedial alternative in the wetlands would only reduce the risk to human health slightly, from low to lower. The LUCs alternative would be protective of the environment in the wetlands because no clearing, grubbing, or excavation would be required.	The LUCs that are recommended in the RI would be implemented to comply with all ARARs and TBCs, including those that protect wetlands.	The components of LUCs that are recommended, particularly warning signs, if instituted effectively, could reduce risk associated with UXO in wetlands. The remedial design will specify steps and controls to be put in place that will ensure the LUCs are maintained, thus ensuring long-term effectiveness and permanence.	No reduction of UXO volume or mobility due to frost heave or erosion in the wetlands would take place under the Alternative 2.	There may be a slight increase in risk to workers, depending on where additional signs were posted. Otherwise, there would be no additional risk to the community or workers because there are no other construction or operation activities in the wetlands associated with this alternative.	Most of the components recommended in the LUC alternative can be easily implemented, as described above.	The presence of wetlands does not impact costs for Alternative 1.	

[1]The cost shown represents the total present-worth cost to perform Alternative 2 in any AOC with low or low-moderate risk. The cost to perform Alternative 2 for AOCs with low or low-moderate risk is summarized in Table 5-9. Detailed cost estimates for Alternative 2 for each AOC are provided in Appendix B.

[2]Regulatory acceptance and community acceptance are typically evaluated during the Proposed Plan. However, because this project was led by PADEP, with involvement from EPA, a preliminary regulatory acceptance discussion has been included to capture regulator involvement and input during the RI/FS.

[3]Approximately 25% of the TOAR-FUDS is covered by wet areas, including wetlands. This discussion addresses wetlands considerations relative to the remedial alternative.

Table 5-3 Evaluation of Alternative 1 for AOCs with High Risk

Alternative	Evaluation	Overall Protectiveness of Human Health and the Environment	Compliance with ARARs and TBCs	Long-Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, or Volume (TMV) of Contaminants Through Treatment	Short-Term Effectiveness	Implementability	Cost[1]	Regulatory Agency Acceptance[2]
1 No Action	General	AOCs TOAR-1, TOAR-2, TOAR-3, TOAR-4, and TOAR-5 at the TOAR-FUDS were evaluated to have high risk in Section 7 of the RI report. UXO densities in these AOCs ranged from 1.9 to 2.6 UXO/acre. The No Action alternative would not address the risk and would therefore not be protective of human health. The No Action alternative would be protective of the environment because no clearing, grubbing, or excavation would be required.	There are no location- or action-specific ARARs associated with the No Action alternative because there are no active remedial actions associated with this alternative.	The magnitude of risk is not expected to reduce significantly over the long term based on intended future land use. The No Action alternative requires no technical components and poses no uncertainties regarding its performance. Site reviews would be conducted once every 5 years as required by CERCLA to assess the site condition and the degree of protectiveness to human health and the environment.	No reduction of UXO volume or mobility due to frost heave or erosion would take place under the Alternative 1.	There would be no additional risk to the community or workers because there are no construction or operation activities associated with this alternative.	Implementation of this alternative poses no technical difficulties. This alternative would be administratively feasible because it requires minimal contact or coordination with agencies to implement.	$94,575	Based on concerns for public safety and the environment, PADEP and EPA Region III would prefer a positive remedial action and would accept the most protective alternative first, down to the least protective alternative. Therefore, Alternative 1 would not be acceptable.
	Wetlands Considerations[2]	As described in Section 7 of the RI, the risk to human health associated with UXO in the wetlands at the TOAR-FUDS is low due to a lack of accessibility and activity. Therefore, any remedial alternative in the wetlands would only reduce the risk to human health slightly, from low to lower. The No Action alternative would be protective of the environment in the wetlands because no clearing, grubbing, or excavation would be required.	Alternative 1 would be protective of the environment in the wetlands, and therefore would be in compliance with ARARs that protect wetlands.	The magnitude of risk in the wetlands is not expected to increase or decrease significantly over the long term based on intended future land use.	No reduction of UXO volume or mobility due to frost heave or erosion in the wetlands would take place under the Alternative 1.	There would be no additional risk to the community or workers because there are no construction or operation activities in the wetlands associated with this alternative.	Implementation of this alternative poses no technical difficulties. This alternative would be administratively feasible because it requires minimal contact or coordination with agencies to implement.	The presence of wetlands does not impact costs for Alternative 1.	

[1]The cost shown represents the total present-worth cost to perform recurring reviews every five years for 30 years Alternative 1 in any AOC with low or low-moderate risk. The cost to perform Alternative 1 for any AOC is summarized in Table 5-8. Detailed cost estimates for Alternative1 for each AOC are provided in Appendix B.

[2]Regulatory acceptance and community acceptance are typically evaluated during the Proposed Plan. However, because this project was led by PADEP, with involvement from EPA, a preliminary regulatory acceptance discussion has been included to capture regulator involvement and input during the RI/FS.

[3]Approximately 25% of the TOAR-FUDS is covered by wet areas, including wetlands. This discussion addresses wetlands considerations relative to the remedial alternative.

Table 5-4 Evaluation of Alternative 2 for AOCs with High Risk

Alternative	Evaluation	Overall Protectiveness of Human Health and the Environment	Compliance with ARARs and TBCs	Long-Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, or Volume (TMV) of Contaminants Through Treatment	Short-Term Effectiveness	Implementability	Cost[1]	Regulatory Agency Acceptance[2]
2 LUCs	General	AOCs TOAR-1, TOAR-2, TOAR-3, TOAR-4, and TOAR-5 at the TOAR-FUDS were evaluated to have high risk in Section 7 of the RI report. UXO densities in these AOCs ranged from 1.9 to 2.6 UXO/acre. The components of LUC that are recommended would raise public awareness and modify public behavior related to the activities they perform at the TOAR-FUDS, which would result in increased protection for human health. Also, the LUCs alternative would be protective of the environment because no clearing, grubbing, or excavation would be required.	The LUCs that are recommended in the RI would be implemented to comply with all ARARs and TBCs.	Alternative 2 is contingent on the cooperation and active participation of the existing powers and authorities of government agencies. The remedial design will specify steps and controls to be put in place that will ensure the LUCs are maintained, thus ensuring long-term effectiveness and permanence. The components of LUCs that are recommended require operation and maintenance of warning signs, printed media, audio and visual media, websites, and a reverse 911 system. Site reviews would be conducted once every 5 years as required by CERCLA to assess the site condition and the degree of protectiveness to human health and the environment.	No reduction of UXO volume or mobility due to frost heave or erosion would take place under Alternative 2.	There may be a slight increase in risk to workers, depending on where additional signs were posted. Otherwise, there would be no additional risk to the community or workers because there are no other construction or operation activities associated with this alternative.	Most of the components recommended in the LUC alternative can be easily implemented because there no technical difficulties associated with this alternative and the materials and services needed to implement this alternative are available. The implementation of a reverse 911 system may require additional technical and operational expertise. Operation and maintenance of warning signs, audio and visual media, and websites can be performed easily.	$1,228,602	Based on concerns for public safety and the environment, PADEP and EPA Region III would prefer a positive remedial action and would accept the most protective alternative first, down to the least protective alternative.
	Wetlands Considerations[3]	As described in Section 7 of the RI, the risk to human health associated with UXO in the wetlands at the TOAR-FUDS is low due to a lack of accessibility and activity. Therefore, any remedial alternative in the wetlands would only reduce the risk to human health slightly, from low to lower. The LUCs alternative would be protective of the environment in the wetlands because no clearing, grubbing, or excavation would be required.	The LUCs that are recommended in the RI would be implemented to comply with all ARARs and TBCs, including those that protect wetlands.	The components of LUCs that are recommended, particularly warning signs, if instituted effectively, could reduce risk associated with UXO in wetlands. The remedial design will specify steps and controls to be put in place that will ensure the LUCs are maintained, thus ensuring long-term effectiveness and permanence.	No reduction of UXO volume or mobility due to frost heave or erosion in the wetlands would take place under the Alternative 2.	There may be a slight increase in risk to workers, depending on where additional signs were posted. Otherwise, there would be no additional risk to the community or workers because there are no other construction or operation activities in the wetlands associated with this alternative.	Most of the components recommended in the LUC alternative can be easily implemented, as described above.	The presence of wetlands does not impact costs for Alternative 1.	

[1]The cost shown represents the total present-worth cost to perform Alternative 2 in any AOC with low or low-moderate risk. The cost to perform Alternative 2 for AOCs with high risk is summarized in Table 5-10. Detailed cost estimates for Alternative 2 for each AOC are provided in Appendix B.

[2]Regulatory acceptance and community acceptance are typically evaluated during the Proposed Plan. However, because this project was led by PADEP, with involvement from EPA, a preliminary regulatory acceptance discussion has been included to capture regulator involvement and input during the RI/FS.

[3]Approximately 25% of the TOAR-FUDS is covered by wet areas, including wetlands. This discussion addresses wetlands considerations relative to the remedial alternative.

Table 5-5 Evaluation of Alternative 3 for AOCs with High Risk

Alternative	Evaluation	Overall Protectiveness of Human Health and the Environment	Compliance with ARARs and TBCs	Long-Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, or Volume (TMV) of Contaminants Through Treatment	Short-Term Effectiveness	Implementability	Cost[1]	Regulatory Agency Acceptance[2]
3 Surface Removal with LUCs	General	AOCs TOAR-1, TOAR-2, TOAR-3, TOAR-4, and TOAR-5 at the TOAR-FUDS were evaluated to have high risk in Section 7 of the RI report. UXO densities in these AOCs ranged from 1.9 to 2.6 UXO/acre. 80% of the UXO items recovered in these AOCs during the RI were located within six (6) inches of the ground surface. Therefore, surface removal of UXO would provide significantly improved protection for human health. Surface removal activities for UXO would not be protective of the environment because they require extensive clearing and grubbing and excavation at the site. LUCs would provide additional protection to human health and the environment, as discussed in Alternative 2.	Surface removal of UXO would be performed so as to comply with all ARARs. LUCs would be implemented to comply with ARARs and TBCs, as discussed in Alternative 2.	Surface removal of UXO would provide long-term effectiveness by permanently removing approximately 80% of the remaining UXO items from AOCs 1, 2, 3, 4, and 5. However, UXO below the surface would remain, and could potentially move to the surface due to frost heave and/or erosion. LUCs would provide additional long-term effectiveness and permanence by assisting in managing risk before, during, and after the removal activity has been conducted. LUCs are described in Alternative 2.	Surface removal and disposal of UXO could reduce the number (or volume) of UXO items in AOCs 1, 2, 3, 4, and 5 by up to 80%. The presence and mobility of UXO items deeper than 6 inches due to frost heave and/or erosion would not be reduced by a surface removal. No reduction of UXO items would occur due to LUCs.	There would be a significant increase in risk to workers while the removal action is conducted. The increased risk to the community during the removal action would be mitigated where possible by the use of engineering controls and/or evacuations to maintain MSDs. LUCs would probably not increase risk to workers or the public, as described in Alternative 2.	Surface removal of UXO has been implemented effectively at the TOAR-FUDS during the RI and during previous investigations. LUCs could be implemented as described in Alternative 2.	$31,625,287	Based on concerns for public safety and the environment, PADEP and EPA Region III would prefer a positive remedial action (i.e. alternatives that include removal activities) and would accept the most protective alternative first, down to the least protective alternative.
	UXO Detection[3]	The detection method used in conjunction with surface removal of UXO, which includes visual observation and analog instrument assistance, will not affect the evaluation of Alternative 3 under this criterion.	The detection method used in conjunction with surface removal of UXO, which includes visual observation and analog instrument assistance, would comply with all ARARs, but would not completely satisfy the DoD and EPA Interim Final Management Principles for Implementing Response Actions at CTT Ranges, which states that "to the maximum extent practicable, the permanent record shall include sensor data that is digitally-recorded and geo-referenced.".	The detection method used in conjunction with surface removal of UXO, which includes visual observation and analog instrument assistance, will not affect the evaluation of Alternative 3 under this criterion.	The detection method used in conjunction with surface removal of UXO, which includes visual observation and analog instrument assistance, will not affect the evaluation of Alternative 3 under this criterion.	The detection method used in conjunction with surface removal of UXO, which includes visual observation and analog instrument assistance, will not affect the evaluation of Alternative 3 under this criterion.	The detection method used in conjunction with surface removal of UXO, which includes visual observation and analog instrument assistance, will not affect the evaluation of Alternative 3 under this criterion.	Costs developed for Alternative 3 include visual observation with analog instrument assistance.	The detection method used in conjunction with surface removal of UXO, which includes visual observation and analog instrument assistance, will not affect the evaluation of Alternative 3 under this criterion.

Table 5-5 Evaluation of Alternative 3 for AOCs with High Risk (continued)

Alternative	Evaluation	Overall Protectiveness of Human Health and the Environment	Compliance with ARARs and TBCs	Long-Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, or Volume (TMV) of Contaminants Through Treatment	Short-Term Effectiveness	Implementability	Cost[1]	Regulatory Agency Acceptance[2]
3 Surface Removal with LUCs (continued)	UXO Disposal[4]	BIP is the only viable method of disposal for UXO at the TOAR-FUDS that is not acceptable to move. C&B is an efficient method of disposal for UXO at the TOAR-FUDS that is acceptable to move. BIP results in a less-confined waste stream than C&B, and is therefore less protective of human health and the environment than C&B. The waste stream could be reduced and protectiveness could be increased through the use of appropriate engineering controls.	Both BIP and C&B would be performed in such a way as to comply with ARARs and TBCs.	Both BIP and C&B are effective and permanent methods for disposing of UXO.	Both BIP and C&B are effective methods for reducing the volume and mobility of UXO.	The risk to workers and to the community associated with BIP procedures is greater than the risk associated with C&B because it is more difficult to control the area around an item disposed of by BIP. Items that are acceptable to move can be disposed of in a more controlled environment. The risk to the community during the disposal could be mitigated where possible by the use of engineering controls and/or evacuations to maintain MSDs.	BIP is the only viable method of disposal for UXO at the TOAR-FUDS that is not acceptable to move. C&B is an efficient method of disposal for UXO at the TOAR-FUDS that is acceptable to move. BIP is more difficult to implement than C&B because it is more difficult to control the area around an item disposed of by BIP.	Costs developed for Alternative 3 include a combination of BIP and C&B, based on the results of the RI.	Both BIP and C&B were acceptable to regulators during the RI.
	Wetlands Considerations[5]	As described in Section 7 of the RI report, the risk to human health associated with UXO in the wetlands at the TOAR-FUDS is low due to a lack of accessibility and activity. Therefore, any removal activity in the wetlands would only reduce the risk to human health slightly, from low to lower. Also, removal of UXO from wetlands at the TOAR-FUDS would require extensive damage (drainage, clearing and grubbing) to be done to the wetlands. Therefore, any removal activity in the wetlands would not be protective of the environment. However, as described in Section 4 of this FS, removal activities would be extended into wet areas as far and as deep as UXO detection and removal equipment allow, and as long as the risk to workers and to the environment could be mitigated.	UXO removal activities in the wetlands would most likely violate 33 CFR 320, Protection of Wetlands.	Removal of UXO from wetlands at the TOAR-FUDS would be more effective in the long-term and more permanent than no removal. As described in Section 4 of this FS, removal activities would be extended into wet areas as far and as deep as UXO detection and removal equipment allow, and as long as the risk to workers and to the environment could be mitigated.	Removal of UXO from wetlands at the TOAR-FUDS would significantly reduce the volume and mobility of UXO in the wetlands. As described in Section 4 of this FS, removal activities would be extended into wet areas as far and as deep as UXO detection and removal equipment allow, and as long as the risk to workers and to the environment could be mitigated.	UXO removal activities in wetlands at the TOAR-FUDS would significantly increase the health and safety risks to workers. As described in Section 4 of this FS, removal activities would be extended into wet areas as far and as deep as UXO detection and removal equipment allow, and as long as the risk to workers and to the environment could be mitigated.	None of the technologies deemed highly viable for UXO detection at the TOAR-FUDS would be implementable inside wetlands due to floating vegetation mats and dense root growth. However, as described in Section 4 of this FS, removal activities would be extended into wet areas as far and as deep as the UXO detection and removal equipment allow, and as long as the risk to workers and to the environment could be mitigated.	Due to the lack of implementable UXO detection technologies inside wet areas at the TOAR-FUDS, and the health and safety risks to workers in wet areas, UXO removal activities in wet areas at the TOAR-FUDS is not considered feasible. Therefore, the wet area shown in Table 1-1 for each AOC has been subtracted from the total area for the purposes of cost estimating.	

[1]The cost shown represents the total present-worth cost to perform Alternative 3 in all high-risk AOCs. The cost to perform Alternative 3 for each AOC is summarized in Table 5-11. Detailed cost estimates for Alternative 3 for each AOC are provided in Appendix B.

[2]Regulatory acceptance and community acceptance are typically evaluated during the Proposed Plan. However, because this project was led by PADEP, with involvement from EPA, a preliminary regulatory acceptance discussion has been included to capture regulator involvement and input during the RI/FS.

[3]UXO Detection addresses relative differences between the most viable detection technologies at the TOAR-FUDS (DGM and M&D).

[4]UXO Disposal addresses relative differences between the most viable disposal technologies at the TOAR-FUDS (BIP and C&B), as well as secondary waste streams generated during disposal.

[5]Approximately 25% of the TOAR-FUDS is covered by wet areas, including wetlands. This discussion addresses wetlands considerations relative to the remedial alternative.

Table 5-6 Evaluation of Alternative 4 for AOCs with High Risk

Alternative	Evaluation	Overall Protectiveness of Human Health and the Environment	Compliance with ARARs and TBCs	Long-Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, or Volume (TMV) of Contaminants Through Treatment	Short-Term Effectiveness	Implementability	Cost[1]	Regulatory Agency Acceptance[2]
4 Removal to One Foot with LUCs	General	AOCs TOAR-1, TOAR-2, TOAR-3, TOAR-4, and TOAR-5 at the TOAR-FUDS were evaluated to have high risk in Section 7 of the RI report. UXO densities in these AOCs ranged from 1.9 to 2.6 UXO/acre. 95% of the UXO items recovered in these AOCs during the RI were located within 12 inches of the ground surface. Therefore, removal of UXO to one foot would provide significantly improved protection for human health. Removal activities for UXO would not be protective of the environment because they require extensive clearing and grubbing and excavation at the site. LUCs would provide additional protection to human health and the environment, as discussed in Alternative 2.	Removal of UXO to one foot would be performed so as to comply with all ARARs. LUCs would be implemented to comply with ARARs and TBCs, as discussed in Alternative 2.	Removal of UXO to one foot would provide long-term effectiveness by permanently removing approximately 95% of the remaining UXO items from AOCs 1, 2, 3, 4, and 5. However, UXO below one foot (approximately 5%) would remain, and could potentially move to the surface due to frost heave and/or erosion. LUCs would provide additional long-term effectiveness and permanence by assisting in managing risk before, during, and after the removal activity has been conducted. LUCs are described in Alternative 2.	Removal and disposal of UXO to one foot could reduce the number (or volume) of UXO items in AOCs 1, 2, 3, 4, and 5 by approximately 95%. The presence and mobility of UXO items deeper than 12 inches due to frost heave and/or erosion would not be reduced by removal to one foot. No reduction of UXO items would occur due to LUCs.	There would be a significant increase in risk to workers while the removal action is conducted. The increased risk to the community during the removal action would be mitigated where possible by the use of engineering controls and/or evacuations to maintain MSDs. LUCs would probably not increase risk to workers or the public, as described in Alternative 2.	Removal of UXO to one foot has been implemented effectively at the TOAR-FUDS during the RI and during previous investigations. LUCs could be implemented as described in Alternative 2.	$53,524,109	Based on concerns for public safety and the environment, PADEP and EPA Region III would prefer a positive remedial action (i.e. alternatives that include removal activities) and would accept the most protective alternative first, down to the least protective alternative.
	UXO Detection[3]	In general, DGM allows for fewer digs than M&D because anomalies below a given threshold are screened out during data analysis. In this way, DGM is more protective of the environment than M&D. DGM generally requires more extensive clearing and grubbing than does M&D, particularly during investigation. In this way, DGM is less protective of the environment than M&D. However, during removal activities in areas containing high densities of UXO, clearing and grubbing for both DGM and M&D will be extensive because the number of digs will be high using either method.	Both DGM and M&D would comply with all ARARs. DGM would more completely satisfy the DoD and EPA Interim Final Management Principles for Implementing Response Actions at CTT Ranges, which states that "to the maximum extent practicable, the permanent record shall include sensor data that is digitally-recorded and geo-referenced."	Both DGM and M&D have been proven effective in detecting UXO items for recovery. DGM provides a permanent, digital record, while M&D does not.	Both DGM and M&D have been proven effective in detecting UXO items for recovery.	Using DGM vs. M&D would not affect the short-term effectiveness of Alternative 4.	DGM equipment was difficult to implement in many areas of the TOAR-FUDS during the RI due to the terrain and the ergonomics of the equipment. M&D equipment was more easily implemented in most areas of the TOAR-FUDS during the RI.	In general, the cost of DGM relative to M&D is higher due to the cost of clearing and grubbing, particularly in areas with lower densities of UXO. However, the cost of DGM relative to M&D can be reduced if the number of digs can be significantly reduced relative to M&D. Costs developed for Alternative 4 include an even combination of DGM and M&D.	DGM would provide regulators with a positive remedial action, and a permanent, digital record. M&D would provide regulators with a positive remedial action, but would not provide regulators with a permanent, digital record.

Table 5-6 Evaluation of Alternative 4 for AOCs with High Risk (continued)

Alternative	Evaluation	Overall Protectiveness of Human Health and the Environment	Compliance with ARARs and TBCs	Long-Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, or Volume (TMV) of Contaminants Through Treatment	Short-Term Effectiveness	Implementability	Cost[1]	Regulatory Agency Acceptance[2]
4 Removal to One Foot with LUCs (continued)	UXO Disposal[4]	BIP is the only viable method of disposal for UXO at the TOAR-FUDS that is not acceptable to move. C&B is an efficient method of disposal for UXO at the TOAR-FUDS that is acceptable to move. BIP results in a less-confined waste stream than C&B, and is therefore less protective of human health and the environment than C&B. The waste stream could be reduced and protectiveness could be increased through the use of appropriate engineering controls.	Both BIP and C&B would be performed in such a way as to comply with ARARs and TBCs.	Both BIP and C&B are effective and permanent methods for disposing of UXO.	Both BIP and C&B are effective methods for reducing the volume and mobility of UXO.	The risk to workers and to the community associated with BIP procedures is greater than the risk associated with C&B because it is more difficult to control the area around an item disposed of by BIP. Items that are acceptable to move can be disposed of in a more controlled environment. The risk to the community during the disposal could be mitigated where possible by the use of engineering controls and/or evacuations to maintain MSDs.	BIP is the only viable method of disposal for UXO at the TOAR-FUDS that is not acceptable to move. C&B is an efficient method of disposal for UXO at the TOAR-FUDS that is acceptable to move. BIP is more difficult to implement than C&B because it is more difficult to control the area around an item disposed of by BIP.	Costs developed for Alternative 4 include a combination of BIP and C&B, based on the results of the RI.	Both BIP and C&B were acceptable to regulators during the RI.
	Wetlands Considerations[5]	As described in Section 7 of the RI report, the risk to human health associated with UXO in the wetlands at the TOAR-FUDS is low due to a lack of accessibility and activity. Therefore, any removal activity in the wetlands would only reduce the risk to human health slightly, from low to lower. Also, removal of UXO from wetlands at the TOAR-FUDS would require extensive damage (drainage, clearing and grubbing) to be done to the wetlands. Therefore, any removal activity in the wetlands would not be protective of the environment. However, as described in Section 4 of this FS, removal activities would be extended into wet areas as far and as deep as UXO detection and removal equipment allow, and as long as the risk to workers and to the environment could be mitigated.	UXO removal activities in the wetlands would most likely violate 33 CFR 320, Protection of Wetlands.	Removal of UXO from wetlands at the TOAR-FUDS would be more effective in the long-term and more permanent than no removal. As described in Section 4 of this FS, removal activities would be extended into wet areas as far and as deep as UXO detection and removal equipment allow, and as long as the risk to workers and to the environment could be mitigated.	Removal of UXO from wetlands at the TOAR-FUDS would significantly reduce the volume and mobility of UXO in the wetlands. As described in Section 4 of this FS, removal activities would be extended into wet areas as far and as deep as UXO detection and removal equipment allow, and as long as the risk to workers and to the environment could be mitigated.	UXO removal activities in wetlands at the TOAR-FUDS would significantly increase the health and safety risks to workers. As described in Section 4 of this FS, removal activities would be extended into wet areas as far and as deep as UXO detection and removal equipment allow, and as long as the risk to workers and to the environment could be mitigated.	None of the technologies deemed highly viable for UXO detection at the TOAR-FUDS would be implementable inside wetlands due to floating vegetation mats and dense root growth. However, as described in Section 4 of this FS, removal activities would be extended into wet areas as far and as deep as the UXO detection and removal equipment allow, and as long as the risk to workers and to the environment could be mitigated.	Due to the lack of implementable UXO detection technologies inside wet areas at the TOAR-FUDS, and the health and safety risks to workers in wet areas, UXO removal activities in wet areas at the TOAR-FUDS is not considered feasible. Therefore, the wet area shown in Table 1-1 for each AOC has been subtracted from the total area for the purposes of cost estimating.	

[1]The cost shown represents the total present-worth cost to perform Alternative 4 in all high-risk AOCs. The cost to perform Alternative 4 for each AOC is summarized in Table 5-12. Detailed cost estimates for Alternative 4 for each AOC are provided in Appendix B.

[2]Regulatory acceptance and community acceptance are typically evaluated during the Proposed Plan. However, because this project was led by PADEP, with involvement from EPA, a preliminary regulatory acceptance discussion has been included to capture regulator involvement and input during the RI/FS.

[3]UXO Detection addresses relative differences between the most viable detection technologies at the TOAR-FUDS (DGM and M&D).

[4]UXO Disposal addresses relative differences between the most viable disposal technologies at the TOAR-FUDS (BIP and C&B), as well as secondary waste streams generated during disposal.

[5]Approximately 25% of the TOAR-FUDS is covered by wet areas, including wetlands. This discussion addresses wetlands considerations relative to the remedial alternative.

Table 5-7 Evaluation of Alternative 5 for AOCs with High Risk

Alternative	Evaluation	Overall Protectiveness of Human Health and the Environment	Compliance with ARARs and TBCs	Long-Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, or Volume (TMV) of Contaminants Through Treatment	Short-Term Effectiveness	Implementability	Cost[1]	Regulatory Agency Acceptance[2]
5 Removal to Detection Depth with LUCs	General	AOCs TOAR-1, TOAR-2, TOAR-3, TOAR-4, and TOAR-5 at the TOAR-FUDS were evaluated to have high risk in Section 7 of the RI report. UXO densities in these AOCs ranged from 1.9 to 2.6 UXO/acre. 95% of the UXO items recovered in these AOCs during the RI were located within 12 inches of the ground surface, and the remaining 5% of the UXO items recovered were between 14 and 24 inches bgs. Therefore, removal of UXO to detection depth would eliminate all of the risk related to UXO and provide significantly improved protection for human health. Removal activities for UXO would not be protective of the environment because they require extensive clearing and grubbing and excavation at the site. LUCs would provide additional protection to human health and the environment as discussed Alternative 2.	Removal of UXO to depth would be performed so as to comply with all ARARs. LUCs would be implemented to comply with ARARs and TBCs, as discussed in Alternative 2.	Removal of UXO to depth would provide long-term effectiveness by permanently removing all of the remaining UXO items from AOCs 1, 2, 3, 4, and 5, including those items that could potentially move to the surface due to frost heave and/or erosion. LUCs would provide additional long-term effectiveness and permanence by assisting in managing risk before, during, and after the removal activity has been conducted. LUCs are described in Alternative 2.	Removal and disposal of UXO to depth could reduce the number (or volume) of UXO items in AOCs 1, 2, 3, 4, and 5 by up to 100% and eliminate the presence and mobility of UXO items deeper than 12 inches that could move to the surface due to frost heave and/or erosion. No reduction of UXO items would occur due to LUCs.	There would be a significant increase in risk to workers while the removal action is conducted. The increased risk to the community during the removal action would be mitigated where possible by the use of engineering controls and/or evacuations to maintain MSDs. LUCs would probably not increase risk to workers or the public, as described in Alternative 2.	Removal of UXO to depth has been implemented effectively at the TOAR-FUDS during the RI and during previous investigations. LUCs could be implemented as described in Alternative 2.	$57,329,902	Based on concerns for public safety and the environment, PADEP and EPA Region III would prefer a positive remedial action (i.e. alternatives that include removal activities) and would accept the most protective alternative first, down to the least protective alternative.
	UXO Detection[3]	In general, DGM allows for fewer digs than M&D because anomalies below a given threshold are screened out during data analysis. In this way, DGM is more protective of the environment than M&D. DGM generally requires more extensive clearing and grubbing than does M&D, particularly during investigation. In this way, DGM is less protective of the environment than M&D. However, during removal activities in areas containing high densities of UXO, clearing and grubbing for both DGM and M&D will be extensive because the number of digs will be high using either method.	Both DGM and M&D would comply with all ARARs. DGM would more completely satisfy the DoD and EPA Interim Final Management Principles for Implementing Response Actions at CTT Ranges, which states that "to the maximum extent practicable, the permanent record shall include sensor data that is digitally-recorded and geo-referenced."	Both DGM and M&D have been proven effective in detecting UXO items for recovery. DGM provides a permanent, digital record, while M&D does not. Using DGM, all items detected are screened relative to a given threshold. DGM allows for multiple screenings of anomalies, thereby reducing the number of smaller or deeper UXO items (i.e. 37-mm in Park) that may go unrecovered. Using M&D, all items detected are recovered. However, M&D equipment is not as sensitive as DGM equipment and does not allow for multiple screenings of anomalies, and therefore, some UXO items may go undetected and unrecovered.	Both DGM and M&D have been proven effective in detecting UXO items for recovery. Using DGM, all items detected are screened relative to a given threshold. DGM allows for multiple screenings of anomalies, thereby reducing the number of smaller or deeper UXO items (i.e. 37-mm in Park) that may go unrecovered. Using M&D, all items detected are recovered. However, M&D equipment is not as sensitive as DGM equipment and does not allow for multiple screenings of anomalies, and therefore, some UXO items may go undetected and unrecovered.	Using DGM vs. M&D would not affect the short-term effectiveness of Alternative 5.	DGM equipment was difficult to implement in many areas of the TOAR-FUDS during the RI due to the terrain and the ergonomics of the equipment. M&D equipment was more easily implemented in most areas of the TOAR-FUDS during the RI.	In general, the cost of DGM relative to M&D is higher due to the cost of clearing and grubbing, particularly in areas with lower densities of UXO. However, the cost of DGM relative to M&D can be reduced if the number of digs can be significantly reduced relative to M&D. Costs developed for Alternative 5 include an even combination of DGM and M&D.	DGM would provide regulators with a positive remedial action, and a permanent, digital record. M&D would provide regulators with a positive remedial action, but would not provide regulators with a permanent, digital record, and may leave small or deep items undetected and unrecovered.

Table 5-7 Evaluation of Alternative 5 for AOCs with High Risk (continued)

Alternative	Evaluation	Overall Protectiveness of Human Health and the Environment	Compliance with ARARs and TBCs	Long-Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, or Volume (TMV) of Contaminants Through Treatment	Short-Term Effectiveness	Implementability	Cost[1]	Regulatory Agency Acceptance[2]
5 Removal to Detection Depth with LUCs (continued)	UXO Disposal[4]	BIP is the only viable method of disposal for UXO at the TOAR-FUDS that is not acceptable to move. C&B is an efficient method of disposal for UXO at the TOAR-FUDS that is acceptable to move. BIP results in a less-confined waste stream than C&B, and is therefore less protective of human health and the environment than C&B. The waste stream could be reduced and protectiveness could be increased through the use of appropriate engineering controls.	Both BIP and C&B would be performed in such a way as to comply with ARARs and TBCs.	Both BIP and C&B are effective and permanent methods for disposing of UXO.	Both BIP and C&B are effective methods for reducing the volume and mobility of UXO.	The risk to workers and to the community associated with BIP procedures is greater than the risk associated with C&B because it is more difficult to control the area around an item disposed of by BIP. Items that are acceptable to move can be disposed of in a more controlled environment. The risk to the community during the disposal could be mitigated where possible by the use of engineering controls and/or evacuations to maintain MSDs.	BIP is the only viable method of disposal for UXO at the TOAR-FUDS that is not acceptable to move. C&B is an efficient method of disposal for UXO at the TOAR-FUDS that is acceptable to move. BIP is more difficult to implement than C&B because it is more difficult to control the area around an item disposed of by BIP.	Costs developed for Alternative 5 include a combination of BIP and C&B, based on the results of the RI.	Both BIP and C&B were acceptable to regulators during the RI.
	Wetlands Considerations[5]	As described in Section 7 of the RI report, the risk to human health associated with UXO in the wetlands at the TOAR-FUDS is low due to a lack of accessibility and activity. Therefore, any removal activity in the wetlands would only reduce the risk to human health slightly, from low to lower. Also, removal of UXO from wetlands at the TOAR-FUDS would require extensive damage (drainage, clearing and grubbing) to be done to the wetlands. Therefore, any removal activity in the wetlands would not be protective of the environment. However, as described in Section 4 of this FS, removal activities would be extended into wet areas as far and as deep as UXO detection and removal equipment allow, and as long as the risk to workers and to the environment could be mitigated.	UXO removal activities in the wetlands would most likely violate 33 CFR 320, Protection of Wetlands.	Removal of UXO from wetlands at the TOAR-FUDS would be more effective in the long-term and more permanent than no removal. As described in Section 4 of this FS, removal activities would be extended into wet areas as far and as deep as UXO detection and removal equipment allow, and as long as the risk to workers and to the environment could be mitigated.	Removal of UXO from wetlands at the TOAR-FUDS would significantly reduce the volume and mobility of UXO in the wetlands. As described in Section 4 of this FS, removal activities would be extended into wet areas as far and as deep as UXO detection and removal equipment allow, and as long as the risk to workers and to the environment could be mitigated.	UXO removal activities in wetlands at the TOAR-FUDS would significantly increase the health and safety risks to workers. As described in Section 4 of this FS, removal activities would be extended into wet areas as far and as deep as UXO detection and removal equipment allow, and as long as the risk to workers and to the environment could be mitigated.	None of the technologies deemed highly viable for UXO detection at the TOAR-FUDS would be implementable inside wetlands due to floating vegetation mats and dense root growth. However, as described in Section 4 of this FS, removal activities would be extended into wet areas as far and as deep as the UXO detection and removal equipment allow, and as long as the risk to workers and to the environment could be mitigated.	Due to the lack of implementable UXO detection technologies inside wet areas at the TOAR-FUDS, and the health and safety risks to workers in wet areas, UXO removal activities in wet areas at the TOAR-FUDS is not considered feasible. Therefore, the wet area shown in Table 1-1 for each AOC has been subtracted from the total area for the purposes of cost estimating.	

[1]The cost shown represents the total present-worth cost to perform Alternative 5 in all high-risk AOCs. The cost to perform Alternative 5 for each AOC is summarized in Table 5-13. Detailed cost estimates for Alternative 5 for each AOC are provided in Appendix B.

[2]Regulatory acceptance and community acceptance are typically evaluated during the Proposed Plan. However, because this project was led by PADEP, with involvement from EPA, a preliminary regulatory acceptance discussion has been included to capture regulator involvement and input during the RI/FS.

[3]UXO Detection addresses relative differences between the most viable detection technologies at the TOAR-FUDS (DGM and M&D).

[4]UXO Disposal addresses relative differences between the most viable disposal technologies at the TOAR-FUDS (BIP and C&B), as well as secondary waste streams generated during disposal.

[5]Approximately 25% of the TOAR-FUDS is covered by wet areas, including wetlands. This discussion addresses wetlands considerations relative to the remedial alternative.

- Alternative 1 – No Action.
- Alternative 2 – Land Use Controls (LUCs).
- Alternative 3 – Surface removal of UXO with LUCs.
- Alternative 4 – Removal of UXO to one foot with LUCs.
- Alternative 5 –Removal of UXO to detection depth with LUCs.

As discussed in subsection 1.3, AOCs with high risk represent impact areas at the TOAR-FUDS. It was assumed for all AOCs with high risk that UXO removal activities would clear the entire AOC, taking into consideration that up to 25% of the AOCs are covered by wet areas, including wetlands. Costs supporting the detailed analysis are provided in Tables 5-8 to 5-13.

5.3 COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES

Based on the detailed analysis of remedial alternatives in Tables 5-1 through 5-7, the strengths and weaknesses of the remedial alternatives relative to one another are evaluated with respect to each of the NCP criteria. Alternatives 1 and 2 are compared for AOCs with low or low-moderate risk in Table 5-14, and Alternatives 1 through 5 are compared for AOCs with high risk in Table 5-15. In each table, the alternatives are evaluated qualitatively, then ranked from best to worst and given a corresponding score of 1 to 2 (for AOCs with low or low-moderate risk) or 1 to 5 (for AOCs with high risk) for each criterion. The scores for each alternative are then totaled in order to develop a relative ranking of alternatives for all AOCs.

Table 5-8 Cost Estimate for Alternative 1 – No Action for Any AOC

CAPITAL COST:

Bid Item No.	Description	QTY	Unit	Team Production (Units/Day)	# Teams	Duration (Weeks)	Weekly Cost Per Team	Total
0100	Work Plans	0.00	LS	N/A	N/A	N/A	80,000	$0
0110	Explosive Safety Submission	0.00	LS	N/A	N/A	N/A	60,000	$0
0200	Mobilization	0.00	LS	N/A	N/A	N/A	36,750	$0
0210	Site-Set-up	0.00	LS	N/A	N/A	N/A	18,098	$0
0300	Site Management	0.00	WEEKS	0.0	0.0	0.0	23,758	$0
0310	Survey/Postioning	0.00	AC	0.0	0.0	0.0	11,810	$0
0320	Brush Clearing	0.00	AC	0.0	0.0	0.0	26,688	$0
0400	Surface MEC Removal	0.00	AC	0.0	0.0	0.0	29,561	$0
0410	Sub-Surface MEC Removal (M&D)	0.00	AC	0.0	0.0	0.0	34,844	$0
0420	Geophysical Mapping	0.00	AC	0.0	0.0	0.0	15,279	$0
0430	Geophysical Data Analysis	0.00	AC	0.0	0.0	0.0	5,875	$0
0440	Anomaly Re-Acquisition	0.00	AC	0.0	0.0	0.0	11,177	$0
0450	Sub-Surface MEC Removal (DGM)	0.00	AC	0.0	0.0	0.0	34,844	$0
0500	MEC Disposal	0.00	AC	0.0	0.0	0.0	22,002	$0
0510	Scrap Disposal	0.00	AC	0.0	0.0	0.0	22,429	$0
0600	Site Restoration	0.00	LS	N/A	N/A	N/A	7,227	$0
0610	Demobilization	0.00	LS	N/A	N/A	N/A	35,750	$0
0700	Final Report	0.00	LS	N/A	N/A	N/A	50,000	$0
0800	Land Use Controls	0.00	LS	N/A	N/A	N/A	86,000	$0
	Sub-Total							$0
	Contingency	15%						$0
	Sub-Total							$0
	Infrastructure Improvements	2%						$0
	Project Management	5%						$0
	Remedial Design (USACE)	8%						$0
	Construction Management (USACE)	6%						$0
	Total Capital Cost							**$0**

ANNUAL O & M COST:

	Description		QTY	Unit	Unit Cost	Total
0900	Land Use Controls - Annual Cost		0	LS	9,500	$0
0910	Construction Support		0	WK	9,021	$0
	Sub-Total					$0
	Contingency	15%				$0
	Total Annual O & M Cost					$0

PERIODIC COST:

	Description	Year	QTY	Unit	Unit Cost	Total
1000	Five Year Review - First Review	5	1	EA	37,500	$37,500
1010	Five Year Review - Years 10,15,20,25 & 30	10 - 30	1	EA	22,500	$22,500

PRESENT VALUE ANALYSIS:

	Cost Type	Year	Total Cost	Total Cost Per Year	Discount Factor (%)	Present Value
	Capitol Cost	0	$0	$0	1	$0
0900	Annual O & M Cost	1 - 30	$0	$0	19.350	$0
0910	Periodic Cost	5	$37,500	$37,500	0.854	$32,025
0920	Periodic Cost	10	$22,500	$22,500	0.737	$16,583
0920	Periodic Cost	15	$22,500	$22,500	0.633	$14,243
0920	Periodic Cost	20	$22,500	$22,500	0.543	$12,218
0920	Periodic Cost	25	$22,500	$22,500	0.467	$10,508
0920	Periodic Cost	30	$22,500	$22,500	0.400	$9,000
			$150,000			$94,575
	Total Present Value of Alternative					**$94,575**

AC = acres, EA = each, LS = lump sum, N/A = not applicable, WK = week

Table 5-9 Cost Estimate for Alternative 2 – Land Use Controls for AOCs with Low or Low-Moderate Risk

CAPITAL COST:

Bid Item No.	Description	QTY	Unit	Team Production (Units/Day)	# Teams	Duration (Weeks)	Weekly Cost Per Team	Total
0100	Work Plans	0.00	LS	N/A	N/A	N/A	80,000	$0
0110	Explosive Safety Submission	0.00	LS	N/A	N/A	N/A	60,000	$0
0200	Mobilization	0.00	LS	N/A	N/A	N/A	36,750	$0
0210	Site-Set-up	0.00	LS	N/A	N/A	N/A	18,098	$0
0300	Site Management	0.00	WEEKS	0.0	0.0	0.0	23,758	$0
0310	Survey/Postioning	0.00	AC	0.0	0.0	0.0	11,810	$0
0320	Brush Clearing	0.00	AC	0.0	0.0	0.0	26,688	$0
0400	Surface MEC Removal	0.00	AC	0.0	0.0	0.0	29,561	$0
0410	Sub-Surface MEC Removal (M&D)	0.00	AC	0.0	0.0	0.0	34,844	$0
0420	Geophysical Mapping	0.00	AC	0.0	0.0	0.0	15,279	$0
0430	Geophysical Data Analysis	0.00	AC	0.0	0.0	0.0	5,875	$0
0440	Anomaly Re-Acquisition	0.00	AC	0.0	0.0	0.0	11,177	$0
0450	Sub-Surface MEC Removal (DGM)	0.00	AC	0.0	0.0	0.0	34,844	$0
0500	MEC Disposal	0.00	AC	0.0	0.0	0.0	22,002	$0
0510	Scrap Disposal	0.00	AC	0.0	0.0	0.0	22,429	$0
0600	Site Restoration	0.00	LS	N/A	N/A	N/A	7,227	$0
0610	Demobilization	0.00	LS	N/A	N/A	N/A	35,750	$0
0700	Final Report	0.00	LS	N/A	N/A	N/A	50,000	$0
0800	Land Use Controls	1.00	LS	N/A	N/A	N/A	86,000	$86,000
	Sub-Total							$86,000
	Contingency	15%						$12,900
	Sub-Total							$98,900
	Infrastructure Improvements	2%						$1,978
	Project Management	5%						$4,945
	Remedial Design (USACE)	8%						$7,912
	Construction Management (USACE)	6%						$5,934
	Total Capital Cost							**$119,669**

ANNUAL O & M COST:

	Description		QTY	Unit	Unit Cost	Total
0900	Land Use Controls - Annual Cost		1	LS	9,500	$9,500
0910	Construction Support		1	WK	9,021	$9,021
	Sub-Total					$18,521
	Contingency	15%				$2,778
	Total Annual O & M Cost					$21,299

PERIODIC COST:

	Description	Year	QTY	Unit	Unit Cost	Total
1000	Five Year Review - First Review	5	1	EA	37,500	$37,500
1010	Five Year Review - Years 10,15,20,25 & 30	10 - 30	1	EA	22,500	$22,500

PRESENT VALUE ANALYSIS:

	Cost Type	Year	Total Cost	Total Cost Per Year	Discount Factor (%)	Present Value
	Capitol Cost	0	$119,669	$119,669	1	$119,669
0900	Annual O & M Cost	1 - 30	$638,975	$21,299	19.350	$412,139
0910	Periodic Cost	5	$37,500	$37,500	0.854	$32,025
0920	Periodic Cost	10	$22,500	$22,500	0.737	$16,583
0920	Periodic Cost	15	$22,500	$22,500	0.633	$14,243
0920	Periodic Cost	20	$22,500	$22,500	0.543	$12,218
0920	Periodic Cost	25	$22,500	$22,500	0.467	$10,508
0920	Periodic Cost	30	$22,500	$22,500	0.400	$9,000
			$908,644			$626,383
	Total Present Value of Alternative					**$626,383**

AC = acres, EA = each, LS = lump sum, N/A = not applicable, WK = week

Table 5-10 Cost Estimate for Alternative 2 – Land Use Controls for AOCs with High Risk

CAPITAL COST:

Bid Item No.	Description	QTY	Unit	Team Production (Units/Day)	# Teams	Duration (Weeks)	Weekly Cost Per Team	Total
0100	Work Plans	0.00	LS	N/A	N/A	N/A	80,000	$0
0110	Explosive Safety Submission	0.00	LS	N/A	N/A	N/A	60,000	$0
0200	Mobilization	0.00	LS	N/A	N/A	N/A	36,750	$0
0210	Site-Set-up	0.00	LS	N/A	N/A	N/A	18,098	$0
0300	Site Management	0.00	WEEKS	0.0	0.0	0.0	23,758	$0
0310	Survey/Postioning	0.00	AC	0.0	0.0	0.0	11,810	$0
0320	Brush Clearing	0.00	AC	0.0	0.0	0.0	26,688	$0
0400	Surface MEC Removal	0.00	AC	0.0	0.0	0.0	29,561	$0
0410	Sub-Surface MEC Removal (M&D)	0.00	AC	0.0	0.0	0.0	34,844	$0
0420	Geophysical Mapping	0.00	AC	0.0	0.0	0.0	15,279	$0
0430	Geophysical Data Analysis	0.00	AC	0.0	0.0	0.0	5,875	$0
0440	Anomaly Re-Acquisition	0.00	AC	0.0	0.0	0.0	11,177	$0
0450	Sub-Surface MEC Removal (DGM)	0.00	AC	0.0	0.0	0.0	34,844	$0
0500	MEC Disposal	0.00	AC	0.0	0.0	0.0	22,002	$0
0510	Scrap Disposal	0.00	AC	0.0	0.0	0.0	22,429	$0
0600	Site Restoration	0.00	LS	N/A	N/A	N/A	7,227	$0
0610	Demobilization	0.00	LS	N/A	N/A	N/A	35,750	$0
0700	Final Report	0.00	LS	N/A	N/A	N/A	50,000	$0
0800	Land Use Controls	1.00	LS	N/A	N/A	N/A	86,000	$86,000
	Sub-Total							$86,000
	Contingency	15%						$12,900
	Sub-Total							$98,900
	Infrastructure Improvements	2%						$1,978
	Project Management	5%						$4,945
	Remedial Design (USACE)	8%						$7,912
	Construction Management (USACE)	6%						$5,934
	Total Capital Cost							**$119,669**

ANNUAL O & M COST:

	Description		QTY	Unit	Unit Cost	Total
0900	Land Use Controls - Annual Cost		1	LS	9,500	$9,500
0910	Construction Support		4	WK	9,021	$36,084
	Sub-Total					$45,584
	Contingency	15%				$6,838
	Total Annual O & M Cost					$52,422

PERIODIC COST:

	Description	Year	QTY	Unit	Unit Cost	Total
1000	Five Year Review - First Review	5	1	EA	37,500	$37,500
1010	Five Year Review - Years 10,15,20,25 & 30	10 - 30	1	EA	22,500	$22,500

PRESENT VALUE ANALYSIS:

	Cost Type	Year	Total Cost	Total Cost Per Year	Discount Factor (%)	Present Value
	Capitol Cost	0	$119,669	$119,669	1	$119,669
0900	Annual O & M Cost	1 - 30	$1,572,648	$52,422	19.350	$1,014,358
0910	Periodic Cost	5	$37,500	$37,500	0.854	$32,025
0920	Periodic Cost	10	$22,500	$22,500	0.737	$16,583
0920	Periodic Cost	15	$22,500	$22,500	0.633	$14,243
0920	Periodic Cost	20	$22,500	$22,500	0.543	$12,218
0920	Periodic Cost	25	$22,500	$22,500	0.467	$10,508
0920	Periodic Cost	30	$22,500	$22,500	0.400	$9,000
			$1,842,317			$1,228,602
	Total Present Value of Alternative					**$1,228,602**

AC = acres, EA = each, LS = lump sum, N/A = not applicable, WK = week

Table 5-11 Cost Estimate for Alternative 3 – Surface Removal of UXO for AOCs with High Risk

CAPITAL COST:

Bid Item No.	Description	AOC 1	AOC 2	AOC 3	AOC 4	AOC 5	TOTAL ALL AOCs
0100	Work Plans	$80,000	$80,000	$80,000	$80,000	$80,000	**$400,000**
0110	Explosive Safety Submission	$60,000	$60,000	$60,000	$60,000	$60,000	**$300,000**
0200	Mobilization	$36,750	$36,750	$36,750	$36,750	$36,750	**$183,750**
0210	Site-Set-up	$18,098	$18,098	$18,098	$18,098	$18,098	**$90,490**
0300	Site Management	$292,910	$887,124	$278,127	$725,939	$548,071	**$2,732,170**
0310	Survey/Postioning	$32,674	$164,750	$30,706	$101,172	$98,220	**$427,522**
0320	Brush Clearing	$590,694	$2,978,381	$555,110	$1,829,018	$1,775,642	**$7,728,845**
0400	Surface MEC Removal	$327,142	$1,649,504	$307,434	$1,012,957	$983,396	**$4,280,433**
0410	Sub-Surface MEC Removal (M&D)	$0	$0	$0	$0	$0	**$0**
0420	Geophysical Mapping	$0	$0	$0	$0	$0	**$0**
0430	Geophysical Data Analysis	$0	$0	$0	$0	$0	**$0**
0440	Anomaly Re-Acquisition	$0	$0	$0	$0	$0	**$0**
0450	Sub-Surface MEC Removal (DGM Picks)	$0	$0	$0	$0	$0	**$0**
0500	MEC Disposal	$73,047	$368,313	$68,646	$226,181	$219,580	**$955,767**
0510	Scrap Disposal	$24,821	$125,154	$23,326	$76,857	$74,614	**$324,772**
0600	Site Restoration	$7,998	$40,327	$7,516	$24,765	$24,042	**$104,647**
0610	Demobilization	$35,750	$35,750	$35,750	$35,750	$35,750	**$178,750**
0700	Final Report	$50,000	$50,000	$50,000	$50,000	$50,000	**$250,000**
0800	Land Use Controls	$86,000	$86,000	$86,000	$86,000	$86,000	**$430,000**
	Sub-Total	$1,715,884	$6,580,150	$1,637,464	$4,363,486	$4,090,162	**$18,387,145**
	Contingency	$257,383	$987,022	$245,620	$654,523	$1,022,540	**$3,167,088**
	Sub-Total	$1,973,267	$7,567,172	$1,883,084	$5,018,008	$5,112,702	**$21,554,233**
	Infrastructure Improvements	$39,465	$151,343	$37,662	$100,360	$102,254	**$431,085**
	Project Management	$98,663	$378,359	$94,154	$250,900	$255,635	**$1,077,712**
	Remedial Design (USACE)	$157,861	$605,374	$150,647	$401,441	$409,016	**$1,724,339**
	Construction Management (USACE)	$118,396	$454,030	$112,985	$301,081	$306,762	**$1,293,254**
	Total Capital Cost	**$2,387,653**	**$9,156,278**	**$2,278,532**	**$6,071,790**	**$6,186,369**	**$26,080,622**

ANNUAL O & M COST:

	Description	Total	Total	Total	Total	Total	**Total**
0900	Land Use Controls - Annual Cost	$9,500	$9,500	$9,500	$9,500	$9,500	**$47,500**
0910	Construction Support	$36,084	$36,084	$36,084	$36,084	$36,084	**$180,420**
	Sub-Total	$45,584	$45,584	$45,584	$45,584	$45,584	**$227,920**
	Contingency	$6,838	$6,838	$6,838	$6,838	$6,838	**$34,188**
	Total Annual O & M Cost	$52,422	$52,422	$52,422	$52,422	$52,422	**$262,108**

PERIODIC COST:

	Description	Total	Total	Total	Total	Total	**Total**
1000	Five Year Review - First Review	$37,500	$37,500	$37,500	$37,500	$37,500	**$187,500**
1010	Five Year Review - Years 10,15,20,25 & 30	$22,500	$22,500	$22,500	$22,500	$22,500	**$112,500**

PRESENT VALUE ANALYSIS:

	Cost Type	Present Value	Present Value	Present Value	Present Value	Present Value	**Present Value**
	Capitol Cost	$2,387,653	$9,156,278	$2,278,532	$6,071,790	$6,186,369	**$26,080,622**
0900	Annual O & M Cost	$1,014,358	$1,014,358	$1,014,358	$1,014,358	$1,014,358	**$5,071,790**
0910	Periodic Cost	$32,025	$32,025	$32,025	$32,025	$32,025	**$160,125**
0920	Periodic Cost	$16,583	$16,583	$16,583	$16,583	$16,583	**$82,913**
0920	Periodic Cost	$14,243	$14,243	$14,243	$14,243	$14,243	**$71,213**
0920	Periodic Cost	$12,218	$12,218	$12,218	$12,218	$12,218	**$61,088**
0920	Periodic Cost	$10,508	$10,508	$10,508	$10,508	$10,508	**$52,538**
0920	Periodic Cost	$9,000	$9,000	$9,000	$9,000	$9,000	**$45,000**
		$3,496,586	$10,265,211	$3,387,464	$7,180,723	$7,295,302	**$31,625,287**
	Total Present Value of Alternative	**$3,496,586**	**$10,265,211**	**$3,387,464**	**$7,180,723**	**$7,295,302**	**$31,625,287**

AC = acres, EA = each, LS = lump sum, N/A = not applicable, WK = week

Table 5-12 Cost Estimate for Alternative 4 – Removal of UXO to One Foot for AOCs with High Risk

CAPITAL COST:

Bid Item No.	Description	AOC 1	AOC 2	AOC 3	AOC 4	AOC 5	TOTAL ALL AOCs
0100	Work Plans	$80,000	$80,000	$80,000	$80,000	$80,000	**$400,000**
0110	Explosive Safety Submission	$60,000	$60,000	$60,000	$60,000	$60,000	**$300,000**
0200	Mobilization	$36,750	$36,750	$36,750	$36,750	$36,750	**$183,750**
0210	Site-Set-up	$18,098	$18,098	$18,098	$18,098	$18,098	**$90,490**
0300	Site Management	$607,475	$1,658,383	$570,880	$1,079,468	$988,690	**$4,904,895**
0310	Survey/Postioning	$32,674	$164,750	$30,706	$101,172	$98,220	**$427,522**
0320	Brush Clearing	$590,694	$2,978,381	$555,110	$1,829,018	$1,775,642	**$7,728,845**
0400	Surface MEC Removal	$490,713	$2,474,256	$461,152	$1,519,435	$1,475,094	**$6,420,649**
0410	Sub-Surface MEC Removal (M&D)	$413,150	$2,083,173	$388,262	$1,279,273	$1,241,940	**$5,405,798**
0420	Geophysical Mapping	$126,816	$639,426	$119,176	$392,670	$381,211	**$1,659,299**
0430	Geophysical Data Analysis	$32,508	$163,913	$30,550	$100,658	$97,721	**$425,350**
0440	Anomaly Re-Acquisition	$92,769	$467,757	$87,181	$287,249	$278,866	**$1,213,822**
0450	Sub-Surface MEC Removal (DGM Picks)	$289,205	$1,458,221	$271,783	$895,491	$869,358	**$3,784,058**
0500	MEC Disposal	$73,047	$368,313	$68,646	$226,181	$219,580	**$955,767**
0510	Scrap Disposal	$24,821	$125,154	$23,326	$76,857	$74,614	**$324,772**
0600	Site Restoration	$9,597	$48,392	$9,019	$29,717	$28,850	**$125,576**
0610	Demobilization	$35,750	$35,750	$35,750	$35,750	$35,750	**$178,750**
0700	Final Report	$50,000	$50,000	$50,000	$50,000	$50,000	**$250,000**
0800	Land Use Controls	$86,000	$86,000	$86,000	$86,000	$86,000	**$430,000**
	Sub-Total	$3,150,068	$12,996,717	$2,982,389	$8,183,787	$7,896,382	**$35,209,344**
	Contingency	$472,510	$1,949,508	$447,358	$1,227,568	$1,184,457	**$5,281,402**
	Sub-Total	$3,622,578	$14,946,225	$3,429,748	$9,411,355	$9,080,840	**$40,490,745**
	Infrastructure Improvements	$72,452	$298,924	$68,595	$188,227	$181,617	**$809,815**
	Project Management	$181,129	$747,311	$171,487	$470,568	$454,042	**$2,024,537**
	Remedial Design (USACE)	$289,806	$1,195,698	$274,380	$752,908	$726,467	**$3,239,260**
	Construction Management (USACE)	$217,355	$896,773	$205,785	$564,681	$544,850	**$2,429,445**
	Total Capital Cost	**$4,383,320**	**$18,084,932**	**$4,149,995**	**$11,387,739**	**$10,987,816**	**$48,993,802**

ANNUAL O & M COST:

	Description	Total	Total	Total	Total	Total	**Total**
0900	Land Use Controls - Annual Cost	$9,500	$9,500	$9,500	$9,500	$9,500	**$47,500**
0910	Construction Support	$36,084	$36,084	$36,084	$36,084	$36,084	**$180,420**
	Sub-Total	$45,584	$45,584	$45,584	$45,584	$45,584	**$227,920**
	Contingency	$6,838	$6,838	$6,838	$6,838	$6,838	**$34,188**
	Total Annual O & M Cost	$52,422	$52,422	$52,422	$52,422	$52,422	**$262,108**

PERIODIC COST:

	Description	Total	Total	Total	Total	Total	**Total**
1000	Five Year Review - First Review	$37,500	$37,500	$37,500	$37,500	$37,500	**$187,500**
1010	Five Year Review - Years 10,15,20,25 & 30	$22,500	$22,500	$22,500	$22,500	$22,500	**$112,500**

PRESENT VALUE ANALYSIS:

	Cost Type	Present Value	Present Value	Present Value	Present Value	Present Value	**Present Value**
	Capitol Cost	$4,383,320	$18,084,932	$4,149,995	$11,387,739	$10,987,816	**$48,993,802**
0900	Annual O & M Cost	$1,014,358	$1,014,358	$1,014,358	$1,014,358	$0	**$4,057,432**
0910	Periodic Cost	$32,025	$32,025	$32,025	$32,025	$32,025	**$160,125**
0920	Periodic Cost	$16,583	$16,583	$16,583	$16,583	$16,583	**$82,913**
0920	Periodic Cost	$14,243	$14,243	$14,243	$14,243	$14,243	**$71,213**
0920	Periodic Cost	$12,218	$12,218	$12,218	$12,218	$12,218	**$61,088**
0920	Periodic Cost	$10,508	$10,508	$10,508	$10,508	$10,508	**$52,538**
0920	Periodic Cost	$9,000	$9,000	$9,000	$9,000	$9,000	**$45,000**
		$5,492,253	$19,193,865	$5,258,928	$12,496,672	$11,082,391	**$53,524,109**
	Total Present Value of Alternative	**$5,492,253**	**$19,193,865**	**$5,258,928**	**$12,496,672**	**$11,082,391**	**$53,524,109**

AC = acres, EA = each, LS = lump sum, N/A = not applicable, WK = week

Table 5-13 Cost Estimate for Alternative 5 – Removal of UXO to Depth for AOCs with High Risk

CAPITAL COST:

Bid Item No.	Description	AOC 1	AOC 2	AOC 3	AOC 4	AOC 5	TOTAL ALL AOCs
0100	Work Plans	$80,000	$80,000	$80,000	$80,000	$80,000	**$400,000**
0110	Explosive Safety Submission	$60,000	$60,000	$60,000	$60,000	$60,000	**$300,000**
0200	Mobilization	$36,750	$36,750	$36,750	$36,750	$36,750	**$183,750**
0210	Site-Set-up	$18,098	$18,098	$18,098	$18,098	$18,098	**$90,490**
0300	Site Management	$680,022	$1,888,536	$639,057	$1,222,411	$1,125,901	**$5,555,927**
0310	Survey/Postioning	$32,674	$164,750	$30,706	$101,172	$98,220	**$427,522**
0320	Brush Clearing	$590,694	$2,978,381	$555,110	$1,829,018	$1,775,642	**$7,728,845**
0400	Surface MEC Removal	$490,713	$2,474,256	$461,152	$1,519,435	$1,475,094	**$6,420,649**
0410	Sub-Surface MEC Removal (M&D)	$578,410	$2,916,443	$543,566	$1,790,982	$1,738,716	**$7,568,117**
0420	Geophysical Mapping	$126,816	$639,426	$119,176	$392,670	$381,211	**$1,659,299**
0430	Geophysical Data Analysis	$32,508	$163,913	$30,550	$100,658	$97,721	**$425,350**
0440	Anomaly Re-Acquisition	$97,652	$492,376	$91,769	$302,367	$293,543	**$1,277,708**
0450	Sub-Surface MEC Removal (DGM Picks)	$385,607	$1,944,295	$362,378	$1,193,988	$1,159,144	**$5,045,411**
0500	MEC Disposal	$73,047	$368,313	$68,646	$226,181	$219,580	**$955,767**
0510	Scrap Disposal	$24,821	$125,154	$23,326	$76,857	$74,614	**$324,772**
0600	Site Restoration	$11,997	$60,490	$11,274	$37,147	$36,063	**$156,970**
0610	Demobilization	$35,750	$35,750	$35,750	$35,750	$35,750	**$178,750**
0700	Final Report	$50,000	$50,000	$50,000	$50,000	$50,000	**$250,000**
0800	Land Use Controls	$86,000	$86,000	$86,000	$86,000	$86,000	**$430,000**
	Sub-Total	$3,491,559	$14,582,930	$3,303,309	$9,159,484	$8,842,046	**$39,379,327**
	Contingency	$523,734	$2,187,440	$495,496	$1,373,923	$1,326,307	**$5,906,899**
	Sub-Total	$4,015,293	$16,770,370	$3,798,805	$10,533,406	$10,168,353	**$45,286,226**
	Infrastructure Improvements	$80,306	$335,407	$75,976	$210,668	$203,367	**$905,725**
	Project Management	$200,765	$838,518	$189,940	$526,670	$508,418	**$2,264,311**
	Remedial Design (USACE)	$321,223	$1,341,630	$303,904	$842,672	$813,468	**$3,622,898**
	Construction Management (USACE)	$240,918	$1,006,222	$227,928	$632,004	$610,101	**$2,717,174**
	Total Capital Cost	**$4,858,505**	**$20,292,147**	**$4,596,554**	**$12,745,421**	**$12,303,707**	**$54,796,334**

ANNUAL O & M COST:

	Description	Total	Total	Total	Total	Total	Total
0900	Land Use Controls - Annual Cost	$9,500	$9,500	$9,500	$9,500	$9,500	**$47,500**
0910	Construction Support	$9,021	$9,021	$9,021	$9,021	$9,021	**$45,105**
	Sub-Total	$18,521	$18,521	$18,521	$18,521	$18,521	**$92,605**
	Contingency	$2,778	$2,778	$2,778	$2,778	$2,778	**$13,891**
	Total Annual O & M Cost	$21,299	$21,299	$21,299	$21,299	$21,299	**$106,496**

PERIODIC COST:

	Description	Total	Total	Total	Total	Total	Total
1000	Five Year Review - First Review	$37,500	$37,500	$37,500	$37,500	$37,500	**$187,500**
1010	Five Year Review - Years 10,15,20,25 & 30	$22,500	$22,500	$22,500	$22,500	$22,500	**$112,500**

PRESENT VALUE ANALYSIS:

	Cost Type	Present Value	Present Value	Present Value	Present Value	Present Value	Present Value
	Capitol Cost	$4,858,505	$20,292,147	$4,596,554	$12,745,421	$12,303,707	**$54,796,334**
0900	Annual O & M Cost	$412,139	$412,139	$412,139	$412,139	$412,139	**$2,060,693**
0910	Periodic Cost	$32,025	$32,025	$32,025	$32,025	$32,025	**$160,125**
0920	Periodic Cost	$16,583	$16,583	$16,583	$16,583	$16,583	**$82,913**
0920	Periodic Cost	$14,243	$14,243	$14,243	$14,243	$14,243	**$71,213**
0920	Periodic Cost	$12,218	$12,218	$12,218	$12,218	$12,218	**$61,088**
0920	Periodic Cost	$10,508	$10,508	$10,508	$10,508	$10,508	**$52,538**
0920	Periodic Cost	$9,000	$9,000	$9,000	$9,000	$9,000	**$45,000**
		$5,365,218	$20,798,861	$5,103,268	$13,252,135	$12,810,420	**$57,329,902**
Total Present Value of Alternative		**$5,365,218**	**$20,798,861**	**$5,103,268**	**$13,252,135**	**$12,810,420**	**$57,329,902**

AC = acres, EA = each, LS = lump sum, N/A = not applicable, WK = week

Table 5-14 Comparative Analysis of Remedial Alternatives for AOCs with Low or Low-Moderate Risk

Alternative	Overall Protectiveness of Human Health and the Environment	Compliance with ARARs and TBCs	Long-Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, or Volume (TMV) of Contaminants Through Treatment	Short-Term Effectiveness	Implementability	Cost	Regulatory Agency Acceptance[1]	Score	Rank
1 No Action	HH: Not protective EN: Protective 2[2]	Not compliant 2	EFF: Not effective PER: Not permanent 2	No reduction 1.5	Not effective 2	Extremely implementable 1	1	No acceptance 2	13.5	**2**
2 LUC	HH: Minimally protective EN: Protective 1	Minimally compliant 1	EFF: Minimally effective PER: Potentially permanent 1	No reduction 1.5	Extremely effective 1	Very implementable 2	2	Acceptance 1	10.5	**1**

HH = Human health; EN = Environment; EFF = Effectiveness; PER = Permanence.

[1]Regulatory agency acceptance is usually evaluated following comment on the FS. However, regulatory agency acceptance is addressed preliminarily in this FS based on input received from PADEP and EPA throughout the project.

[2]Scores indicate the relative ranking of alternatives under each criteria, with 1 = best alternative for that criteria, and 2 = worst alternative for that criteria. Alternatives with the same relative ranking under a specific criterion receive a score of 1.5. The scores are then totaled, and the alternative with the lowest score receives a relative ranking of 1.

Table 5-15 Comparative Analysis of Remedial Alternatives for AOCs with High Risk

Alternative	Overall Protectiveness of Human Health and the Environment	Compliance with ARARs and TBCs	Long-Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, or Volume (TMV) of Contaminants Through Treatment	Short-Term Effectiveness	Implementability	Cost	Regulatory Agency Acceptance[1]	Score	Rank
1 No Action	HH: Not protective EN: Protective 5[2]	Not compliant 5	EFF: Not effective PER: Not permanent 5	No reduction 4.5	Not effective 5	Most implementable 1	1	Not acceptable 5	31.5	**5**
2 LUC	HH: Minimally protective EN: Protective 4	Minimally compliant 4	EFF: Minimally effective PER: Potentially permanent 4	No reduction 4.5	Most effective 1	More implementable 2	2	Minimally acceptable 4	25.5	**4**
3 Surface Removal of UXO with LUCs	HH: Protective EN: Disruptive 3	Compliant 3	EFF: Effective PER: Permanent 3	Up to 80% reduction 3	More effective 2	Implementable 4	3	Acceptable 3	24	**3**
4 Removal of UXO to One Foot with LUCs	HH: More protective EN: More disruptive 1.5	More compliant 2	EFF: More effective PER: More permanent 2	Approximately 95% reduction 2	Effective 3	Implementable 4	4.5	More acceptable 2	21	**2**
5 Removal of UXO to Detection Depth with LUCs	HH: Most protective EN: Most disruptive 1.5	Most compliant 1	EFF: Most effective PER: Most permanent 1	Approximately 100% reduction 1	Minimally effective 4	Implementable 4	4.5	Most acceptable 1	18	**1**

HH = Human health; EN = Environment; EFF = Effectiveness; PER = Permanence.

[1]Regulatory agency acceptance is usually evaluated following comment on the FS. However, regulatory agency acceptance is addressed preliminarily in this FS based on input received from PADEP and EPA throughout the project.

[2]Scores indicate the relative ranking of alternatives under each criteria, with 1 = best alternative for that criteria, and 5 = worst alternative for that criteria. Alternatives with the same relative ranking under a specific criterion receive the average of successive scores (i.e. two alternatives tied for second would get a rating of [2+3]/2 = 2.5). The scores are then totaled, and the alternative with the lowest score receives a relative ranking of 1.

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APPENDIX A

COMMENTS AND REPONSES

DRAFT FEASIBILITY STUDY

Comments by John S. Mellow, PADEP Regional Project Officer
February 22, 2005

Draft Feasibility Study
Former Tobyhanna Artillery Ranges
Tobyhanna, Pennsylvania
11 February 2005

The preliminary review comments had been discussed at the technical meeting held on February 16, 2005. Several of the items that this reviewer had questions on and have been briefly discussed were:

- The deletion of the "Chemical Specific ARARs)" section would not affect any of the potential Feasibility Study (FS) remedial alternatives. The evaluation of the environmental samples collected during the Remedial Investigation (RI) fieldwork has been planned in coordination with, and subsequently discussed with the USEPA Biological and Technical Assistance Group (BTAG) and U.S. Army Corps risk assessors. If there is no objection with this collective expertise, or with subsequent Technical Review Committee (TRC) commentors, then the deletion of this section is appropriate.

Response: This issue was discussed with CENAB Office of Counsel, and it was agreed that chemical-specific ARARs are not required if it is determined in the RI that there are no chemicals of concern at the site, and therefore no remedial alternatives will be developed to address chemicals.

- The amount of wetlands areas subtracted out of the final areas is conservative and appropriate for evaluating alternatives during a FS. Providing the wetland map(s) as discussed would supplement this information.

Response: The wetlands are now shown on all maps in the RI report, and on the single map (Figure 1-1) provided in the FS.

- Table 3-1 (Page 3-6) does acknowledge technologies that would not be viable at Tobyhanna but have been brought up as possible options by representatives of non-government organizations (NGOs). An additional thought on this would be potential technologies that may develop or be considered for pilot scale tests at TOAR. The Recurring Reviews (meeting the requirements of the CERCLA Five Year Reviews) would be able to incorporate this information as needed. As an additional note on Marine Side Band Sonar (or any other wetland investigative technique to be considered in Recurring Reviews), personal experience has shown even canoe access is not possible in some areas (Oakes Swamp) and large floating vegetation mats, and dense root growth that even makes sediment collection difficult in some areas might be factors to consider.

Response: Comment on potential technologies noted. Added text to Table 3-1 and to subsection 3.2.2.1 to reflect comments regarding vegetation mats and dense root growth in wetlands.

- The potential for MEC surfacing due to frost/heave is suggested to be considered in comparison of surface and one-foot clearance to the clearance to detection depth. The RI data would indicate that the majority of the ordnance is on or near the surface, but some MEC has been found at greater than one foot. Considering this it would appear that the FS should note that long-term effectiveness of surface and one-foot clearance would need to insure that appropriate long-term O & M measures are considered. This might be noted in the description of the **Long-term effectiveness and permanence** criteria in Section 5.1, Page 5-2 or Table 5-2.

Response: The mobility of MEC due to frost heave/erosion is now considered in the detailed evaluation tables in Section 5 under the "Reduction of Toxicity, Mobility, and Volume" criterion.

Section 1.2, Page 1-3: This section states: *"The Pennsylvania Game Commission (PGC) uses some of the land in Game for food plots and timber sales."* Considering the PGC maps provided to Weston that would indicate the majority of the area of SGL127 is plotted for timber sales at some potential point in time, could this be elaborated on if correct? At present the "some" is correct but consider that the selected alternative would need to consider that timber plots could be in many areas of SGL127.

Response: The sentence has been revised to read "The PGC uses some of the land in Game for food plots, and has designated much of the land in Game for future timber sales."

Section 3.1, Page 3-1: The DOD terminology is only slight different that that used for non-DOD sites. However, the "No DOD Action Indicated (NDAI)" and "Land Use Controls (LUC)" alternatives should be noted as comparable to "No Action" and "Institutional Controls" alternatives if this statement is correct. If DOD definitions differ slightly this should also be noted.

Response: Replaced "No DOD Action Indicated" with "No Action" per CENAB Office of Counsel comments. For MEC sites, "Land Use Controls" has replaced "Institutional Controls," according to CEHNC.

Date: 2 March 2005

Reviewer: Clyde Lichtenwalner

Discipline: Environmental Engineer – HTRW -RID

1. Page 1-10. Section 1.3.3. Last sentence. I am not sure that just because there was agreement between the original CSM, data collected in the field, and revised CSM that you can conclude the site has been adequately characterized. The outcome of the investigation could have suggested major changes in the original CSM, but have been adequate. The data collected in the RI confirms that with slight modifications to boundaries, the original CSM was fairly accurate. The adequacy of the characterization is subject to one's definition of adequate. I suggest striking the last sentence.

Response: Made suggested change.

2. Page 5-13, Table 5-3. Reverse 991 should be changed to reverse 911. What does LS mean, It is not in the table of acronyms.

Response: Changed "Reverse 991" to "reverse 911." LS means Lump Sum, and has been added to the list of acronyms and abbreviations. EA and LS are now defined in the notes for each cost estimate table.

5 March, 2005

Comments on Draft FS for the TOAR

by George Follett

1. Page ES-3, Last para - "General remedial...that will that should" - pick one.

Response: Deleted "that should."

2. Page 3-9, Last para, last full sentence on page - States that engineering controls like sandbag walls and sandbag mounds will be used during intrusive investigations of potential MEC items. Sandbags are not feasible in this application, it would be cost prohibitive. I would leave it at 'engineering controls'.

Response: Deleted "such as sand bag mounds and sand bag walls over and around the potential UXO item" and ended sentence at "engineering controls."

3. Table 5-4, "Description" column, third item - "Explosive Saffety Submission" - safety misspelled.

Response: Made suggested correction to Table 5-4.

End.

TOAR Draft FS Report Comments – Reviewer: Cliff Opdyke

1. Executive summary, ES-2 – language is used that states that MC concentrations in various media are "protective" – this is not the correct word to use as it implies that not only are the concentrations not bad, but that they confer some sort of "protection". The language that is commonly used in risk assessments to convey lack of risk is the term, "no unacceptable risk" – yes, it is a double negative, but it is a phrase that has worked well these past 15 years.

Response: Replaced "are protective of" with "present no acceptable risk to.".

2. Tables 5-1 and 5-2 – under the "Regulatory Agency Acceptance" column is the same innocuous sentence for each alternative that states nothing about whether the agency would accept a particular remedial option. An indication should be made for each alternative whether or not the regulatory agencies would be more accepting or not, otherwise this column need not be present.

Response: The description of Regulatory Agency Acceptance will be refined in the Draft Final and Final FS. The comparative analysis table ranks alternatives according to their acceptability to regulators.

CENAB-EN-GG 9 March 2005

Draft Tobyhanna Feasibility Study Report

Geology & Investigation Section comments

Reviewer – Tom Colozza

1) Section 5: The removal action alternatives are not optimized for site-wide terrain variability. More practical alternative would utilize the advantages of various detection methods. At a minimum one alternative for the 4-foot and 1-foot clearance scenarios should include a combination of DGM and M&D or other combination of technologies.

Response: The FS cost estimates have been revised to include a combination of DGM and M&D in for all removal alternatives in all AOCs.

2) Tables 5-4 to 5-9: The cost for clearing and grubbing required for M&D vs. mag DGM should be similar. Please clarify why the different handheld instruments in general would require a much greater level of clearing (50%)?

Response: The assumption that clearing and grubbing for DGM would be more extensive than for M&D is based on the site conditions and the level of effort required to achieve comprehensive DGM data coverage during the RI (i.e. clean data with no gaps).

3) Tables 5-4 to 5-9: The tables do not include the cost for the actual mag effort. There should be a separate line item for anomaly locating and flagging.

Response: It was assumed that the crews will mag and dig, rather than mag, flag, then dig, because it is more efficient to mag and dig.

4) Table 5-11: It appears the cost to dig every anomaly using the M&D method has not been factored into the cost analysis. The number of digs resulting from a M&D survey at the four impact areas would be considerably more compared to a DGM survey. The cost associated with say digging 33% more targets with M&D is not reflected in table 5-11 analysis. (The number of additional digs weather it be 33%, 25% or 10% is debatable).

Response: New line items in the cost estimate tables for removal alternatives show production rates for DGM and M&D. The production rates shown for DGM are higher than the production rates shown for M&D, which reflects the fact that DGM will result in fewer digs than M&D.

5) Table 5-11: For implementability, why is the DGM rated a 7? For most of the TOAR site DGM is implementable.

Response: The detailed evaluation and comparative analysisin Section 5 has been revised significantly in the Draft Final FS. In the detailed evaluation tables, MEC Detection methods (i.e. DGM and M&D) are now discussed and compared as part of the detailed evaluation of each removal alternative (i.e. surface, one foot, to depth). In the comparative analysis, only the removal alternatives are compared and ranked, not the methods/technologies.

U. S. ARMY ENGINEERING AND SUPPORT CENTER - HUNTSVILLE

CORPS OF ENGINEERS

DESIGN REVIEW COMMENTS

PROJECT:Tobyhana FS CN:03-070-05 Suspense:16MAR2005

■ SITE DEV & GEO ☐ ENVIR PROT& UTIL ☐ ARCHITECTURAL ☐ STRUCTURAL

☐ MECHANICAL ☐ MFG TECHNOLOGY ☐ ELECTRICAL ☐ INST & CONTROLS

☐ SAFETY ☐ ADV TECH ☐ ESTIMATING ☐ SPECIFICATIONS

☐ SYSTEMS ENG ☐ VALUE ENG ☐ OTHER

REVIEW Draft FS-TOAR
DATE 11Feb2005
NAME a.schwartz/ED-CS-G

ITEM	DRAWING NO. OR REFERENCE	COMMENT	ACTION
1		This FS does not present the information that is needed to formulate objective clean-up decisions. Much of what is presented as fact, or technical state-of-the-art, or required procedures, is more subjective interpretations from the authors. For this FS to be meaningful within the confines of the NPL definitions, the authors must explain how the NPL terms and criteria are to be "interpreted" in the MEC domain. Regardless of what the format of the FS is, the following should be made available to the readers: 1- Identify which technologies are viable at TOAR. Do not attempt to influence the decision makers towards those technologies that the authors know how to use. If the authors don't know how to use a technology, then they should consult with someone who does, before giving it an inferior rating. For costing purposes, explain any assumptions or differences between what would normally be considered "equal" approaches (e.g. DGM magnetic methods and DGM TDEM methods are usually about equal from the context of site preparation needs, data positioning/collection needs, processing needs, reacquisition needs, etc.) 2- For each AOC, assess all of the characteristics that influence detection capabilities, only for those MEC that were found in that AOC, and then formulate various alternatives that are specific to how a geophysical technology would need to be used. 3- One key fact that will influence decisions is the percentage of MEC recovered from different depth groups. Key data elements that are needed to support MEC removal decisions are breakdowns of expected MEC recovery percentages, separately by individual MEC type and for all MEC, grouped into logical depth groups. By logical, the groupings would likely be based on depths, anticipated MEC quantities and anticipated false positives/non-MEC quantities [note: Weston does not present a credible argument to discount the EM61, nor does Weston	This general response is offered to the reviewer based on the results of our 22 April 2005 meeting to address comments provided on the RI and FS report for the TOAR-FUDS. The FS has been revised significantly to focus more on remedial alternatives as opposed to detection equipment used to implement the remedial alternative, as previously presented in the Draft FS. The various technologies available for MEC detection, positioning, removal, excavation, and treatment of waste streams are discussed and screened in Section 3 of the FS so that future decision-makers can make more-informed decisions. However, those technologies have not been carried over into Sections 4 or 5 of the FS. Instead, the remedial alternatives described in Section 4 and evaluated against the NCP criteria in Section 5 include only the following: 1. No Action 2. LUCs 3. Surface removal of MEC 4. Removal of MEC to One Foot 5. Removal of MEC to Depth In the tables in Section 5, for each alternative, under each criterion, additional consideration is given to MEC detection techniques, MEC disposal

ACTION CODES
A - ACCEPTED/CONCUR
D - ACTION DEFERRED
W - WITHDRAWN
N - NON-CONCUR
VE - VE POTENTIAL/VEP ATTACHED

ITEM	DRAWING NO. OR REFERENCE	COMMENT	ACTION
		provide critical information in regards to possible cost savings associated with using a methodology that is less sensitive to hot rocks. This is a major deficiency in this FS and must be addressed before clean-up decisions can be made.] It is expected that for analog approaches, the hot rock count, and clearance costs, will drastically increase as the required detection depth increases. However, using DGM, these would very likely only increase minimally since 75mm and 155mm produce very distinct anomalies at depths of 2 feet or less. Sites where 37mm are an issue, the analog costs would not change significantly compared to 75mm/155mm sites, but the DGM costs would increase. Basically, this FS is lacking data that would normally come from a treatability study. 4- Once the above are explained, the FS should summarize what the different clean-up objectives really mean in terms of how much we reduce hazards as a factor of cost and schedule. The above approach, though not directly following the NPL method, provides the information needed to make informed decisions.	techniques, and wetlands. Also as discussed in the 22 April 2005 meeting, the RI will be revised significantly based on comments received from CEHNC. The RI will include additional information regarding lines of evidence used to characterize the site (i.e. visual evidence, both positive and negative, additional local knowledge, etc.), and will present revised conceptual site model maps. These changes to the RI will be captured in Section 1 of the Final FS, but have not all been captured in the Draft Final FS due to PADEP schedule constraints.
2		This FS is not considered complete for the following reasons: 1- See the issues raised in Comment #1 above regarding cost and hazard reductions, appropriateness of alternatives in regards to specific AOC characteristics. 2- Significant comments raised in the RI have not been resolved, regarding adequate characterization, meaningful boundaries, etc. Therefore, accurate and meaningful costs can not yet be assessed. 3- The authors presume an “adaptive clearance” method. This proves that the RI is incomplete. What about other methods, why are they not also	

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A - ACCEPTED/CONCUR N - NON-CONCUR
D - ACTION DEFERRED VE - VE POTENTIAL/VEP ATTACHED

DESIGN REVIEW COMMENTS

PROJECT:Tobyhana FS CN:03-070-05 Suspense:16MAR2005

■ SITE DEV & GEO ☐ MECHANICAL ☐ SAFETY ☐ SYSTEMS ENG
☐ ENVIR PROT& UTIL ☐ MFG TECHNOLOGY ☐ ADV TECH ☐ VALUE ENG
☐ ARCHITECTURAL ☐ ELECTRICAL ☐ ESTIMATING ☐ OTHER
☐ STRUCTURAL ☐ INST & CONTROLS ☐ SPECIFICATIONS

REVIEW Draft FS-TOAR
DATE 11Feb2005
NAME a.schwartz/ED-CS-G

ITEM	DRAWING NO. OR REFERENCE	COMMENT	ACTION
		formulated into alternatives? 4- The authors subjectively bias technology ratings based on what was done during the RI. In many instances, the reasoning used to assess "effectiveness", "implementability" and "Viability for Former TOAR are inconsistent between the technologies listed in tables 3-1, 3-2, and 3-4. As a consequence, Table 3-5 is incomplete. 5- TDEM and advanced signal processing of magnetic and/or TDEM data was not tested to determine if "hot rock" false-positives can be minimized. 6- Marine geophysics is well established, and several shallow water systems are available for UXO detection. 7- What is the definition of surface? This FS implies items that are buried to a depth of 6 inches or less. I do not believe this is not consistent with MEC industry practices.	
3.	Tables in Chapter 5	1- Trees grow back, and grubbing often removes forest fire fuel. Also, with the significant increase in hot rock digs and frag digs that are always associated with analog alternatives, it's very unlikely that any MEC remedial action would be "more" or "less" protective of the environment than another. 2- There is no proof that analog geophysical remedies will be as effective at detecting buried MEC than digital geophysical remedies (this FS lacks a treatability study). In fact, it is generally accepted that analog remedies are less consistent than digital remedies, and therefore (lacking site specific treatability data) it should be assumed that they are likely to be less effective than digital remedies. As a consequence, this FS understates the estimated numbers of UXO that would be left after an	

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DESIGN REVIEW COMMENTS

PROJECT:Tobyhana FS CN:03-070-05 Suspense:16MAR2005

■ SITE DEV & GEO ☐ MECHANICAL ☐ SAFETY ☐ SYSTEMS ENG
☐ ENVIR PROT& UTIL ☐ MFG TECHNOLOGY ☐ ADV TECH ☐ VALUE ENG
☐ ARCHITECTURAL ☐ ELECTRICAL ☐ ESTIMATING ☐ OTHER
☐ STRUCTURAL ☐ INST & CONTROLS ☐ SPECIFICATIONS

REVIEW Draft FS-TOAR
DATE 11Feb2005
NAME a.schwartz/ED-CS-G

ITEM	DRAWING NO. OR REFERENCE	COMMENT	ACTION
		analog remedy is performed. 3- The scoring factors in Table 5-11 are inconsistent, and appear to have been manipulated to artificially decrease the ranking score of analog remedies (to make them more favorable). For instance, analog remedies do not comply with the ARAR/TBC of the DoD/EPA MOU for this site, yet it has been stated that the areas can be cleared for DGM remedies, and there appear to be no conditions that would preclude the use of DGM. Still, mag and flag is considered almost compliant, when it is not. Other rankings that are inconsistent between alternatives: overall protectiveness of the environment (do the authors believe that a site would be grubbed to a lesser degree even when mechanical excavations are to be used?); Effectiveness (In the RI, almost all of the anomalies were detected with DGM; how can it be deduced that analog will be equally effective?); Implementability (the FS fails to address the real limitations facing the MEC industry in being able to prove that the analog remedy is applied consistently throughout a project. Implementability means more than "how easy is it to use", it also has to factor for "does it work all the time")	
4.		Due to the deficiencies and omissions explained above, detailed comments will not be provided.	

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W - WITHDRAWN
N - NON-CONCUR
VE - VE POTENTIAL/VEP ATTACHED

U. S. ARMY ENGINEERING AND SUPPORT CENTER - HUNTSVILLE

CORPS OF ENGINEERS

DESIGN REVIEW COMMENTS

PROJECT Tobyhanna FS CN 03-070-05 SD 16 March 2005

☐ SITE DEV & GEO ☐ ENVIR PROT& UTIL ☐ ARCHITECTURAL ☐ STRUCTURAL
☐ MECHANICAL ☐ MFG TECHNOLOGY ☐ ELECTRICAL ☐ INST & CONTROLS
☐ SAFETY ☐ ADV TECH ☐ ESTIMATING ☐ SPECIFICATIONS
☐ SYSTEMS ENG ☐ VALUE ENG ■ OTHER

REVIEW Draft
DATE 18 March 2005
NAME Deborah Walker/CEHNC-OE-CX/256-895-1796

ITEM	DRAWING NO. OR REFERENCE	COMMENT	ACTION
1	General	Given that this is intended to be a stand-alone, additional information on MC should be provided. The summary provided does not provide enough detail to support the no additional action required recommendation for MC.	As discussed in the 22 April 2005 meeting, the RI has been revised to include additional information to support the conclusion that there are no chemicals of concern at the site. Subsection 1.3.2 of the FS is intended to summarize the information and conclusions presented in the RI, not to present all the information contained in the risk assessment again.
2	General, Terminology	MC is not a subset of MEC. They are each subsets of the MMRP. Generally, the definitions used aren't used correctly.	The definition of munitions constituents in the Executive Summary and in Section 1 of the FS has been revised based on comments from CEHNC and from CENAB Office of Counsel.
3	1.3.2, pg. 1-8	As noted in RI comments, I don't concur that you have proven your case. Strongly recommend that HTRW CX risk assessor review be conducted of RI (particularly SLRA) and FS.	As discussed in the 22 April 2005 meeting, the RI has been revised to include additional information to support the conclusion that there are no chemicals of concern at the site. Also, the HTRW CX risk assessor has reviewed the Draft Final RI report. Those comments will be addressed in the RI report.
4	Table 2-1	Chemical Specific ARARs/TBCs should be included on this table.	This issue was discussed with CENAB Office of Counsel, and it was agreed that chemical-specific ARARs are not required if it is determined in the RI that there are no chemicals of concern at the site, and therefore no remedial alternatives will be developed to address chemicals.
5	Table 3-4	Every technology except RSP has an MC-related waste stream to deal with. All also have MD waste streams to deal with. This hasn't been addressed for most	Treatment alternatives for waste streams resulting from MEC disposal activities have been included as

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DESIGN REVIEW COMMENTS PROJECT Tobyhanna FS CN 03-070-05 SD 16 March 2005

☐ SITE DEV & GEO ☐ MECHANICAL ☐ SAFETY ☐ SYSTEMS ENG
☐ ENVIR PROT& UTIL ☐ MFG TECHNOLOGY ☐ ADV TECH ☐ VALUE ENG
☐ ARCHITECTURAL ☐ ELECTRICAL ☐ ESTIMATING ■ OTHER
☐ STRUCTURAL ☐ INST & CONTROLS ☐ SPECIFICATIONS

REVIEW Draft
DATE 18 March 2005
NAME Deborah Walker/CEHNC-OE-CX/256-895-1796

ITEM	DRAWING NO. OR REFERENCE	COMMENT	ACTION
		of the table. Specifically, BIP, consolidated shot, and laser yield unconfined release of MC and MD. CDCs yield confined release of MC and MD, which must still be disposed of appropriately. CDC technologies are also limited to “acceptable to move” ordnance. (“Safe to move” is inappropriate terminology.)	Table 3-5. Waste stream considerations have also been included in the detailed evaluation of remedial alternatives in Section 5.

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U. S. ARMY ENGINEERING & SUPPORT CENTER, HUNTSVILLE | Tobyhanna Artillery Range FS, CN: 03-070-05 | CORPS OF ENGINEERS

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PROJECT

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☐ STRUCTURAL ☐ INST & CONTROLS ☐ SPECIFICATIONS

REVIEW Draft
DATE Monday, May 09, 2005
NAME Bill Veith, MM-CX, 256-895-1592

ITEM	DRAWING NO. OR REFERENCE	COMMENT	ACTION
1.	Page 1-1, paragraph 1	At the end of the first subparagraph explain how much sampling was completed to make the statement "There are no specific chemical contaminants of concern associated with the Site." I can see the statement, as written, being a red flag to the regulators.	This sentence was deleted from Page 1-1. The issue of chemical constituents of concern is addressed later in subsection 1.3.2, after a description of the sampling and risk assessment that was conducted.
2.	Page 2-1, paragraph 2	At the bottom of the page AR 385-64 is listed as a TBC but it is not included in Table 2-1. The other TBC listed in the paragraph is included in the table. You might want to list DA Pam 385-64 since it is the how to portion of the guidance for explosives safety. The AR lists the responsibilities and other administrative aspects.	All safety requirements were deleted from Table 2-1, per CENAB Office of Counsel.
3.	Page 3-9, paragraph 3.2.2.1	At the end of the paragraph the statement is made that "Therefore, detection technologies are not currently available to perform UXO detection in the wetlands that exist at the former TOAR. I disagree with this statement. The Huntsville Center has successfully geophysically mapped small lakes and other small bodies of water. The excavation of anomalies has proven to be the difficult part. Getting permission to drain the wetlands is hard. The evaluation of the alternative should be considered in this document.	The technology is screened against the three (3) criteria in Section 3. Also, wetlands considerations are included in the detailed evaluation tables in Section 5. The paragraph on page 3-9 was revised to read as follows: "As described in the RI report, approximately 25% of the TOAR-FUDS consist of lakes, streams, ponds, and wetland areas that are continually submerged, and adjacent areas that are intermittently submerged, depending on precipitation amounts and intensities. The lakes, ponds, and wetland areas include large vegetation mats and dense root growth. Therefore, technologies currently available for detection of MEC in marine environments would not be effective in the wet areas that exist at the TOAR-FUDS."
4.	Page 3-9, paragraph 3.2.2.2	In the last paragraph on the page delete "The MSD is calculated based on the explosive characteristics of the munition with the greatest fragmentation distance (MGFD) that may be present within the sector" and insert in its place "The MSD is based on the munition with the greatest fragmentation distance (MGFD) that	Made suggested changes.

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REVIEW DATE Monday, May 09, 2005
NAME Bill Veith, MM-CX, 256-895-1592

ITEM	DRAWING NO. OR REFERENCE	COMMENT	ACTION
		may be present within the sector." The statement as originally written is not correct. Also, in the next sentence delete "/non-UXO." The heavy equipment operators may be present and non UXO qualified.	
5.	Page 3-13, Table 3-4	In some of the evaluations the term "safe-to-move" is used for MEC that will be consolidated for disposal. Delete this term and insert MEC that the risk of moving has been determined to be acceptable. There is an additional risk when MEC is moved even though in most cases it is very small. We do not want the regulatory community to get the impression that UXO are "safe." They may want us to ship it to a treatment facility. Change this here and anywhere else it appears in the document.	Replaced "safe to move" with "acceptable to move" throughout the report.
6.	Page 4-6, paragraph 4.1.3.6	This paragraph states that a backhoe can only be used to excavate within 12 inches of the detected anomaly, then hand excavation must be used to remove the item. How do we determine that an anomaly is deeper that 12 "? The other question is how much do we gain with the use of heavy equipment since 95% of all UXOs are in the first 12 inches? That means we are allowing the use of heavy equipment when only 5% of the anomalies are deeper than 12 inches and we can not tell when an anomaly is deep enough to use the heavy equipment. Explain why this is in the document.	The discussion of hand excavation and mechanical excavation using a backhoe in Section 4 has been deleted. Excavation methods/equipment are now identified and evaluated only in Section 3 (Table 3-3), and are not evaluated in further detail in Sections 4 or 5.
7.	Page 4-9, Table 4-2	These removal action alternatives need to be evaluated relative to each other. The effectiveness in this table is evaluated based on the reduction of risk at the site which is not IAW paragraph 3.2.1.1. The Implementability and Cost comparisons are also not IAW chapter 3. This table needs to be corrected.	Table 4-2 was revised to reflect this comment.
8.	Page 5-2, paragraph 5.1, number 4	The last sentence states "to the extent that UXO is detected, recovered, and disposed of, its ability to move is reduced." I am sure the intent is to determine the ability of the UXO remaining, after the remedial action has been completed, to move is what should be evaluated. It is very easy to say that what is treated is not able to move. Correct this statement.	The statement cited was taken directly from CEHNC "draft for discussion" guidance titled "CERCLA Nine Criteria. Integration of MMRP in the RI/FS Process." However, we agree that this statement falls short. Therefore, the following sentence was added to the end of the definition: "MEC remaining after a removal activity would maintain its ability to move, based on the physical processes described

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DESIGN REVIEW COMMENTS PROJECT

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REVIEW
DATE Monday, May 09, 2005
NAME Bill Veith, MM-CX, 256-895-1592

ITEM	DRAWING NO. OR REFERENCE	COMMENT	ACTION
			above, and should be accounted for."
9.	General comment to the geophysical equipment/procedures	I am leaving the geophysical comments up to the reviewer trained in that discipline. I can see many errors associated with the geophysics but a geophysicist can evaluate the different geophysical methods and equipment included in this document and compare them to each other.	No response required.

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TOAR Draft FS Report Comments – Reviewer: Jim Manthey (CEHNC)

Comment 1. Non-human environmental impacts were not assessed a part of the effectiveness criterion. Issues such as effect of brush cutting/tree cutting and the amount of digging required to meet the removal effectiveness must be assessed for their impact on the environment.

Response: Environmental impacts on the remedial alternatives are captured within the Implementability criterion, since the implementability of a remedial alternative (particularly a removal activity) will be affected by site features such as terrain, tree density, canopy, etc. Long-Term Effectiveness considers the ability of an alternative to maintain protection of human health and the environment over time. Short-Term Effectiveness considers the risks the alternative poses to workers, residents, and the environment during implementation.

Comment 2. The response alternatives are not fully developed. No physical removal for MEC is 100% effective. The analysis shold include an assessment of potential residual MEC as well as risk management inclusion in some or all response alternatives as appropriate for that potential residual.

Response: Agreed…no physical removal of MEC is 100% effective. Even Table 5-7, which evaluates Alternative 5 – Removal to Depth, acknowledges that "Removal and disposal of MEC to depth could reduce the number (or volume) of MEC items…by up to 100%." That is why LUCs are included with all removal alternatives. LUCs include recurring reviews, signs, public education, etc., as described in subsection 4.1.2. Therefore, to clarify this issue, the following text has been added to the tables in Section 5 under the Long-Term Effectiveness and Permanence criterion for Alternatives 3, 4, and 5: "LUCs would provide additional long-term effectiveness and permanence by assisting in managing risk before, during, and after the removal activity has been conducted. LUCs are described in Alternative 2."

TOUR Feasibility Study Report (Draft)

Comments, Questions, & Corrections

Submitted by TRC Member, Michael S. Winters
Park Manager, Tobyhanna State Park Complex
DCNR

Executive Summary. Page ES-3: First sentence in last paragraph typo "…that will that should." Page ES-4 "Removal of UXO to Detection Depth." Detection depth is not explained until section 3. Provide some explanation of detection depth in the executive summary.

Response: Deleted "that should." Added text from Section 3 to Executive Summary to describe all removal activities.

Section 1: Are the 2 UXO items found in the Lake Watawga area still within the park? If so, this could be better explained on page 1-7 when the report describes the necessity for treating the Lake Watawga area differently.

Response: Revised sentence to read "A separate area within Park and near Lake Watawga was identified, and is treated independently in the RI, based on its proximity to residential housing." This area is not treated differently, but treated separately as AOC TOAR-1.

Section 4: Who conducts recurring reviews?

Response: Recurring reviews are conducted by USACE. Added text to 2nd paragraph of subsection 4.1 to reflect this.

Section 4, page 4-3: "Each grid will have to be cleared and grubbed." Please define "cleared and grubbed" and address restoration of areas that are cleared and grubbed.

Response: Clearing and grubbing consists of clearing shrubs and small trees (up to 3 inches thick) in order to allow for MEC detection and positioning equipment to function and move effectively and efficiently. Site restoration would be addressed in the remedial design. That level of detail is not usually included in an FS.

Section 4, page 4-4: "LUC will be implemented as described in Alternative 2." Please be specific as to which Land Use Control methods will be applied or recommended.

Response: LUCs are described more thoroughly in subsection 4.1.2. A reference to this subsection was added throughout Section 4.

Section 4, page 4-8: Last sentence of last paragraph should probably read "…Alternatives 3 through 8 will not be evaluated for AOCs with low risk."

Response: Made suggested change.

Section 5, page 5-13, Table 5-3: Please define the 2% infrastructure improvements cost.

Response: Infrastructure improvements would repair/restore/replace infrastructure (roads, trails, buildings, etc.) affected by remedial activities. 2% is just a standard value used for cost estimating purposes.

Section 5, Tables 5-4 through 5-9: Although estimated costs for "brush clearing" fluctuate depending on the AOC being cleared, the cost for "site restoration" remains constant in all AOCs. Please explain the source for this estimate on site restoration.

Response: Clearing and grubbing costs fluctuate based on the size of the AOC and the expected number of anomalies to be dug. The costs for site restoration have been revised to also reflect the size of the AOC and the expected number of anomalies to be dug.

General questions: How much clearing, brushing, and grubbing are actually going to occur? Is Weston going to exercise some restraint in the clearing and brushing of wooded areas? Who will be responsible for bearing the costs of reseeding/replanting areas that are extensively cleared?

Response: Clearing and grubbing is necessary in order to effectively and efficiently detect MEC. Based on the future intended land use at the site, all steps would be taken to reduce the amount of clearing and grubbing necessary to perform a removal activity. However, in areas containing high densities of MEC, significant clearing, grubbing, and excavation will be required to effectively and efficiently detect and recover MEC. . Site restoration would be addressed in the remedial design. That level of detail is not usually included in an FS.

DRAFT FINAL FEASIBILITY STUDY

Date: 20 May 2005

Reviewer: Clyde Lichtenwalner

Discipline: Environmental Engineer – HTRW -RID

Subject: Review of *Draft Final Feasibility Study, Tobyhanna Artillery Range*

1. Figure 1-1. The caption boxes appear to have multiple pointers. This could be confusing for areas such as AOC TOAR-4 and AOC TOAR-5. and AOC TOAR-2 where the boxes seem to be pointing to two locations.

Response: This issue has been addressed in the RI version of this figure (Figure 9-1 in the RI), and will be addressed in the FS as well.

2. Page 2-1, Section 2, second last paragraph on the page. Delete the first "no" in the sentence as it is redundant. The sentence should read: "TBCs are used when there are no ARARs…"

Response: Made suggested change.

3. Table 3-4, under the notes column for Render Safe Procedures row. The acronym RSP is not in the acronym list, and not introduced in the Technology column as are others (eg. BIP, C&B, etc).

Response: RSP has been defined in the Technology column in Table 3-4, and RSP has been included in the Acronyms and Abbreviations list.

4. Table3-4, Under the Cost column, in the Consolidate and Blow row, MHE is introduced and not included in the acronym list.

Response: Materials handling equipment (MHE) has been added to the acronym list and to Table 3-4.

5. Table 3-4, Under Notes Column, in the Contained Detonation Chambers Stationary row. PPE is not found in the acronym list. PPE is used again in the Contained Detonation Chambers Mobile row under notes.

Response: PPE has been added to the acronym list and defined in the Notes column in Table 3-4.

6. Page 4-4, Section 4.1.3.1. The explanation of adaptive clearance in the second last paragraph of the section leaves some doubt as to what is being done. I have trouble picturing what is meant by saying the extent of the area delineated for inspection and initial clearance is bounded using two sets of 100 x 100 grids on

all sides, including diagonals. Perhaps a diagram would help. This comment also applies to Section 4.1.3.2.1. on page 4-5, last paragraph on the page (similar explanation of adaptive clearance).

Response: Based on other comments received from CEHNC, all references to and descriptions of adaptive clearance were removed from the report.

7. Table 5-2, Evaluation of Alternative 2 for AOCs with Low or Low-Moderate Risk. There seems to be an error in footnote 1 of this table and Table 5-9. The footnote refers to Table 5-9 as a summary of cost to perform Alternative 2 for any AOC. Table 5-9 estimates $1,228,602, not $626,383. I note from appendix B that the cost of LUCs is not the same for high risk AOCs and low risk AOCs (Unlike Alternative 1, No Action). Table 5-9 is presenting the cost for high risk AOCs ($1,228,602). A new table is needed for low risk AOCs.

Response: Table 5-4 was revised to reference the correct cost for Alternative 2 for AOCs with high risk ($1,222,602), and the correct table that summarizes those costs (Table 5-10). New Table 5-9 was added to summarize the cost of Alternative 2 for AOCs with low to low-moderate risk ($626,383). Old Table 5-9 was changed to new Table 5-10. All references to cost tables were updated.

8. Table 5-4, Evaluation of Alternative 2 for AOCs with High Risk. The cost of $626,383 is not the cost in Table 5-9. Footnote 1 indicates that Table 5-9 provides the cost to perform Alternative 2 for any AOC. This is incorrect. As in the comment above, a new table is needed for the low risk AOCs. The cost on this table should be changed to $1,228,602.

Response: See response to Comment #7 above.

9. Table5-6, Evaluation of Alternative 4 for AOCs with high Risk. The footnotes on this table are incorrectly numbered. Under the Evaluation column, MEC Detection should be footnoted 3, not 2. Similarly MEC Disposal should be footnoted 4, not 3, and Wetlands Considerations should be footnoted 5, not 4.

Response: Made suggested changes.

10. Table 5-7, Evaluation of Alternative 5 for AOCs with high Risk. Under the Evaluation column, MEC Detection should be footnoted 3, not 2. Similarly MEC Disposal should be footnoted 4, not 3, and Wetlands Considerations should be footnoted 5, not 4.

Response: Made suggested changes.

11. I do not understand why the costs for Alternative 4 are more than Alternative 5. This is counter intuitive because we are digging more anomalies under Alternative 5. My intuitive conjecture is verified under the Capital Cost estimate,

but it appears that there is some saving in annual O&M construction support that tips the balance toward Alternative 5. I do not see this saving in annual O&M discussed anywhere. I can not imagine why there is a difference in Annual Construction O&M between Alternative 4&5, when there appears to be no difference in Annual Construction O&M between Alternatives 3 and 4. Perhaps this should be discussed in Column 1 of Table 5-7 so that the reader can be sure there is no error in transcription.

Response: The Annual Construction O&M Costs include costs for Construction Support. The assumption is that more construction support (4 weeks in the cost estimates) would be required after either a surface removal or a removal to one foot because deeper items would still be present that could move to the surface due to frost heave or be uncovered during construction. On the other hand, much less construction support (one week in the cost estimates) would be required after a clearance to depth because no items would remain. That annual cost, projected out over 30 years, accounts for the large difference in O&M costs between Alternative 4 and Alternative 5.

However, the efficiency of the field work (acres cleared per day) for Alternative 5 relative to Alternative 4 was reduced further, which results in more days required to complete Alternative 5, which results in a greater total cost to perform Alternative 5, as shown in Tables 5-6 and 5-7. The revised total cost to perform Alternative 5 is $67,570,531, compared to $62,627,841 for Alternative 4.

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DESIGN REVIEW COMMENTS

PROJECT: TOAR FS CN:05-048-05 Suspense:24MAY2005

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REVIEW Draft Final TOAR FS
DATE 6May2005
NAME a.schwartz/ED-CS-G

ITEM	DRAWING NO. OR REFERENCE	COMMENT	ACTION
1	General	It should be noted that the strategies, equipment, procedures, etc. used by the contractor during the RI were designed specifically for characterizing the TOAR FUDS. It should not be assumed that any of those strategies, equipment or procedures will necessarily be applicable to meet the objectives of a remedial response at this site. The FS should be revised to remove all prescriptive language specifying which instrumentation to use, how work is to be performed, or how data is to be interpreted, for any remedial response. Some of the comments below address some such instances in this FS.	This general comment is addressed in the responses to comments that follow.
2	Table 3-2 and Table 3-6	USAESCH does not concur that acoustic methods have a High viability at the TOAR FUDS. This is the only system that was used by the contractor, and it was not very implementable throughout the TOAR FUDS, as detailed in the RI report. Other systems, such as RTS, and even line and fiducial positioning, have been proven to be much more implementable than acoustics. As recommended in USAESCH comments on the draft FS, the authors are again encouraged to contact specialist in the various fields of positioning technologies for accurate details about implementability, cost, effectiveness, etc.	Table 3-2 was revised to reduce the Implementability of Acoustic method to Medium (with a subsequent discussion), and reduce the Viability to Medium to High. Table 3-2 was also revised to increase the Viability of RTS to Medium to High. Based on those changes, Table 3-6 was revised to include positioning systems with a Medium to High Viability at the TOAR-FUDS, which includes RTS, Fiducial Method, and Acoustic Method. Also note that all the text describing and evaluating the various positioning technologies in Table 3-2 was pulled directly from the USAESCH guidance table, titled “Positioning Technologies (Table 2),” which comes from the Word file named “MEC Positioning Technologies Final.doc,” which was distributed to WESTON in April 2005. The only modifications WESTON made to the guidance table were to include brief discussions of how technologies fared at the TOAR-FUDS (if they were

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			used), and subsequent changes to the qualitative rankings based on our specific site.
3.	Section 4.1.3, MEC Removal	Throughout section 4.1.3, the authors have prescribed how work will be performed, in what appears to be text that has been copied and pasted from a work plan. USAESCH does not concur that this type of prescriptive instruction is appropriate for an FS. The FS should be revised to remove all prescriptive instructions on how to perform any given alternative. It should not be assumed that grids will be used, nor which instrumentation will be used or how it will be used. Based on target areas as defined in this FS, USAESCH does not concur that criteria for defining clearance boundaries should be included in the FS (i.e. the "adaptive clearance" strategy.)	All text in subsection 4.1.3 describing specific procedures for conducting a MEC clearance was removed. The following text was inserted in subsection 4.1.3.1 and 4.1.3.2 to describe general tasks to be completed as part of a MEC clearance using analog and digital detection methods: "Surface removal of MEC includes removal of MEC detected on the ground surface and breaching the ground surface using visual observation and analog instrument assistance. The following general tasks would be included as part of Alternative 3: ▪ Development of a Work Plan. ▪ Mobilization. ▪ Survey/positioning. ▪ Brush clearing and grubbing. ▪ MEC detection. ▪ MEC removal. ▪ MEC disposal. ▪ Scrap disposal. ▪ Demobilization. Waste streams generated from MEC disposal will be addressed as appropriate, using either recycling or treatment. LUCs will be implemented as

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			described in Alternative 2 in subsection 4.1.2." "The following general tasks would be included as part of Alternative 4 using digital detection methods: ▪ Development of a Work Plan. ▪ Mobilization. ▪ Survey/positioning. ▪ Brush clearing and grubbing. ▪ Geophysical mapping. ▪ Geophysical data analysis. ▪ Anomaly reacquisition. ▪ MEC removal. ▪ MEC disposal. ▪ Scrap disposal. ▪ Demobilization. Waste streams generated from MEC disposal will be addressed as appropriate, using either recycling or treatment. LUCs will be implemented as described in Alternative 2 in subsection 4.1.2." All references to and descriptions of adaptive clearance were removed from the report.
4.	Table 5-7	1. It should not be assumed that a simple threshold screening criteria would be used for the remedial response. Further, either an item is detected or is not detected when using any geophysical tool. It is the	In Table 5-7, under columns "Long-Term Effectiveness and Permanence" and "Reduction of Toxicity, Mobility, and Volume…" revised text to

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		interpretation process and/or anomaly selection criteria that remove detected items from dig lists, or result in them not being excavated. Therefore, once it is discovered that an item has been "screened out" of a dig list generated from DGM data, the data is re-analyzed using modified anomaly selection criteria and new dig lists are produced, thereby reducing the likelihood that a smaller or deeper MEC item goes unrecovered. This method of problem resolution is not available for analog M&D approaches. 2. The M&D (analog) equipment referred to in this FS IS less sensitive than DGM equipment, and some buried MEC items WILL go undetected if they are small or deep. 3. Not all items that are detected using M&D are actually removed because the site has "hot rocks" and small frag from functioned ordnance, and it is not possible to discern hot rocks and small frag from buried metal using analog M&D. This condition leads to "masking", and without removing all detected items, including hot rocks and all frag, it is not possible to state that all metallic items will actually be detected and removed.	read as follows: "Using DGM, all items detected are screened relative to a given threshold. DGM allows for multiple screenings of anomalies, thereby reducing the number of smaller or deeper MEC items (i.e. 37-mm in Park) that may go unrecovered. Using M&D, all items detected are recovered. However, M&D equipment is not as sensitive as DGM equipment and does not allow for multiple screenings of anomalies, and therefore, some MEC items may go undetected and unrecovered." In Table 5-7, under columns "Regulatory Agency Acceptance" revised text to read as follows: "M&D would provide regulators with a positive remedial action, but would not provide regulators with a permanent, digital record, and may leave small or deep items undetected and unrecovered."
5.	Table 5-6 and Table 5-7	It does not seem logical that Alternative 5 is less costly that Alternative 4, particularly since 1) greater numbers of digs will be performed in Alternative 5 and 2) more of the digs will require mechanical excavation in Alternative 5.	The Annual Construction O&M Costs include costs for Construction Support. The assumption is that more construction support (4 weeks in the cost estimates) would be required after either a surface removal or a removal to one foot because deeper items would still be present that could move to the surface due to frost heave or be uncovered during construction. On the other hand, much less construction support (one week in the cost estimates) would be required after a clearance to depth because no items would remain. That annual

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PROJECT: TOAR FS CN:05-048-05 Suspense:24MAY2005

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NAME a.schwartz/ED-CS-G

ITEM	DRAWING NO. OR REFERENCE	COMMENT	ACTION
		No Further Comments	cost, projected out over 30 years, accounts for the large difference in O&M costs between Alternative 4 and Alternative 5. However, based on the two factors discussed in the comment, the efficiency of the field work (acres cleared per day) for Alternative 5 relative to Alternative 4 was reduced further, which results in more days required to complete Alternative 5, which results in a greater total cost to perform Alternative 5, as shown in Tables 5-6 and 5-7. The revised total cost to perform Alternative 5 is $67,570,531, compared to $62,627,841 for Alternative 4.

ACTION CODES
A - ACCEPTED/CONCUR
D - ACTION DEFERRED
W - WITHDRAWN
N - NON-CONCUR
VE - VE POTENTIAL/VEP ATTACHED

U. S. ARMY ENGINEERING AND SUPPORT CENTER - HUNTSVILLE

CORPS OF ENGINEERS

DESIGN REVIEW COMMENTS

PROJECT Tobyhanna FS CN 05-048-05 SD 24 May 2005

☐ SITE DEV & GEO ☐ ENVIR PROT& UTIL ☐ ARCHITECTURAL ☐ STRUCTURAL
☐ MECHANICAL ☐ MFG TECHNOLOGY ☐ ELECTRICAL ☐ INST & CONTROLS
☐ SAFETY ☐ ADV TECH ☐ ESTIMATING ☐ SPECIFICATIONS
☐ SYSTEMS ENG ☐ VALUE ENG ■ OTHER

REVIEW Draft Final
DATE 24 May 2005
NAME Deborah Walker/CEHNC-OE-CX/256-895-1796

ITEM	DRAWING NO. OR REFERENCE	COMMENT	ACTION
1	General	Previous comments have been responded to appropriately and incorporated.	
2	Table 3-4	Engineering controls don't reduce releases of MC. They would presumably make the area of effect smaller, but it is currently unknown whether more or less MC is released. I suspect that the amount of MD is also similar, but defer to Michelle Crull for a definitive answer.	Changed "reduced" to "restricted" where engineering controls are discussed in the Effectiveness column of Table 3-4.

ACTION CODES
A - ACCEPTED/CONCUR
D - ACTION DEFERRED
W - WITHDRAWN
N - NON-CONCUR
VE - VE POTENTIAL/VEP ATTACHED

U. S. ARMY ENGINEERING & SUPPORT CENTER, HUNTSVILLE | Tobyhanna FS comment back check. | CORPS OF ENGINEERS

DESIGN REVIEW COMMENTS

PROJECT

☐ SITE DEV & GEO	☐ MECHANICAL	☐ SAFETY	☐ SYSTEMS ENG	REVIEW: Draft Final
☐ ENVIR PROT& UTIL	☐ MFG TECHNOLOGY	☐ ADV TECH	☐ VALUE ENG	DATE: Tuesday, July 26, 2005
☐ ARCHITECTURAL	☐ ELECTRICAL	☐ ESTIMATING	☒ OE CX	NAME: Bill Veith, MM-CX, 256-895-1592
☐ STRUCTURAL	☐ INST & CONTROLS	☐ SPECIFICATIONS		

ITEM	DRAWING NO. OR REFERENCE	COMMENT	ACTION
1.	Page ES-3	Delete “increasing public awareness of MEC” bullet under Reduce or eliminate potential MEC exposure pathways by. Increasing public does not reduce or eliminate a pathway.	Both subbullets under “Reduce or eliminate potential MEC exposure pathways” were deleted on page ES-3 and 1-11.
2.	General	I still do not think this effort has fulfilled the requirement to determine the nature and extent of contamination. I understand that no more field work is going to be performed so what we have is what will be used. I do feel that I needed to make this statement for future projects when this issue will arise. I do not want this to be a precedent setter.	No response required.
3.			
.			

ACTION CODES
A - ACCEPTED/CONCUR
D - ACTION DEFERRED
W - WITHDRAWN
N - NON-CONCUR
VE - VE POTENTIAL/VEP ATTACHED

APPENDIX B

COST ESTIMATES

COST ESTIMATES FOR ALTERNATIVE 1 – NO ACTION

AOC No:1
Alternative No: 1
No Action

CAPITAL COST:

Bid Item No.	Description	QTY	Unit	Team Production (Units/Day)	# Teams	Duration (Weeks)	Weekly Cost Per Team	Total
0100	Work Plans	0.00	LS	N/A	N/A	N/A	80,000	$0
0110	Explosive Safety Submission	0.00	LS	N/A	N/A	N/A	60,000	$0
0200	Mobilization	0.00	LS	N/A	N/A	N/A	36,750	$0
0210	Site-Set-up	0.00	LS	N/A	N/A	N/A	18,098	$0
0300	Site Management	0.00	WEEKS	0.0	0.0	0.0	23,758	$0
0310	Survey/Postioning	0.00	AC	0.0	0.0	0.0	11,810	$0
0320	Brush Clearing	0.00	AC	0.0	0.0	0.0	26,688	$0
0400	Surface MEC Removal	0.00	AC	0.0	0.0	0.0	29,561	$0
0410	Sub-Surface MEC Removal (M&D)	0.00	AC	0.0	0.0	0.0	34,844	$0
0420	Geophysical Mapping	0.00	AC	0.0	0.0	0.0	15,279	$0
0430	Geophysical Data Analysis	0.00	AC	0.0	0.0	0.0	5,875	$0
0440	Anomaly Re-Acquisition	0.00	AC	0.0	0.0	0.0	11,177	$0
0450	Sub-Surface MEC Removal (DGM)	0.00	AC	0.0	0.0	0.0	34,844	$0
0500	MEC Disposal	0.00	AC	0.0	0.0	0.0	22,002	$0
0510	Scrap Disposal	0.00	AC	0.0	0.0	0.0	22,429	$0
0600	Site Restoration	0.00	LS	N/A	N/A	N/A	7,227	$0
0610	Demobilization	0.00	LS	N/A	N/A	N/A	35,750	$0
0700	Final Report	0.00	LS	N/A	N/A	N/A	50,000	$0
0800	Land Use Controls	0.00	LS	N/A	N/A	N/A	86,000	$0
	Sub-Total							$0
	Contingency	15%						$0
	Sub-Total							$0
	Infrastructure Improvements	2%						$0
	Project Management	5%						$0
	Remedial Design (USACE)	8%						$0
	Construction Management (USACE)	6%						$0
	Total Capital Cost							**$0**

ANNUAL O & M COST:

	Description		QTY	Unit	Unit Cost	Total
0900	Land Use Controls - Annual Cost		0	LS	9,500	$0
0910	Construction Support		0	WK	9,021	$0
	Sub-Total					$0
	Contingency	15%				$0
	Total Annual O & M Cost					$0

PERIODIC COST:

	Description	Year	QTY	Unit	Unit Cost	Total
1000	Five Year Review - First Review	5	1	EA	37,500	$37,500
1010	Five Year Review - Years 10,15,20,25 & 30	10 - 30	1	EA	22,500	$22,500

PRESENT VALUE ANALYSIS:

	Cost Type	Year	Total Cost	Total Cost Per Year	Discount Factor (%)	Present Value
	Capitol Cost	0	$0	$0	1	$0
0900	Annual O & M Cost	1 - 30	$0	$0	19.350	$0
0910	Periodic Cost	5	$37,500	$37,500	0.854	$32,025
0920	Periodic Cost	10	$22,500	$22,500	0.737	$16,583
0920	Periodic Cost	15	$22,500	$22,500	0.633	$14,243
0920	Periodic Cost	20	$22,500	$22,500	0.543	$12,218
0920	Periodic Cost	25	$22,500	$22,500	0.467	$10,508
0920	Periodic Cost	30	$22,500	$22,500	0.400	$9,000
			$150,000			$94,575
	Total Present Value of Alternative					**$94,575**

AC = acres, EA = each, LS = lump sum, N/A = not applicable, WK = week

AOC No:2
Alternative No: 1
No Action

CAPITAL COST:

Bid Item No.	Description	QTY	Unit	Team Production (Units/Day)	# Teams	Duration (Weeks)	Weekly Cost Per Team	Total
0100	Work Plans	0.00	LS	N/A	N/A	N/A	80,000	$0
0110	Explosive Safety Submission	0.00	LS	N/A	N/A	N/A	60,000	$0
0200	Mobilization	0.00	LS	N/A	N/A	N/A	36,750	$0
0210	Site-Set-up	0.00	LS	N/A	N/A	N/A	18,098	$0
0300	Site Management	0.00	WEEKS	0.0	0.0	0.0	23,758	$0
0310	Survey/Postioning	0.00	AC	0.0	0.0	0.0	11,810	$0
0320	Brush Clearing	0.00	AC	0.0	0.0	0.0	26,688	$0
0400	Surface MEC Removal	0.00	AC	0.0	0.0	0.0	29,561	$0
0410	Sub-Surface MEC Removal (M&D)	0.00	AC	0.0	0.0	0.0	34,844	$0
0420	Geophysical Mapping	0.00	AC	0.0	0.0	0.0	15,279	$0
0430	Geophysical Data Analysis	0.00	AC	0.0	0.0	0.0	5,875	$0
0440	Anomaly Re-Acquisition	0.00	AC	0.0	0.0	0.0	11,177	$0
0450	Sub-Surface MEC Removal (DGM)	0.00	AC	0.0	0.0	0.0	34,844	$0
0500	MEC Disposal	0.00	AC	0.0	0.0	0.0	22,002	$0
0510	Scrap Disposal	0.00	AC	0.0	0.0	0.0	22,429	$0
0600	Site Restoration	0.00	LS	N/A	N/A	N/A	7,227	$0
0610	Demobilization	0.00	LS	N/A	N/A	N/A	35,750	$0
0700	Final Report	0.00	LS	N/A	N/A	N/A	50,000	$0
0800	Land Use Controls	0.00	LS	N/A	N/A	N/A	86,000	$0
	Sub-Total							$0
	Contingency	15%						$0
	Sub-Total							$0
	Infrastructure Improvements	2%						$0
	Project Management	5%						$0
	Remedial Design (USACE)	8%						$0
	Construction Management (USACE)	6%						$0
	Total Capital Cost							**$0**

ANNUAL O & M COST:

	Description		QTY	Unit	Unit Cost	Total
0900	Land Use Controls - Annual Cost		0	LS	9,500	$0
0910	Construction Support		0	WK	9,021	$0
	Sub-Total					$0
	Contingency	15%				$0
	Total Annual O & M Cost					$0

PERIODIC COST:

	Description	Year	QTY	Unit	Unit Cost	Total
1000	Five Year Review - First Review	5	1	EA	37,500	$37,500
1010	Five Year Review - Years 10,15,20,25 & 30	10 - 30	1	EA	22,500	$22,500

PRESENT VALUE ANALYSIS:

	Cost Type	Year	Total Cost	Total Cost Per Year	Discount Factor (%)	Present Value
	Capitol Cost	0	$0.00	$0.00	1	$0
0900	Annual O & M Cost	1 - 30	$0	$0	19.350	$0
0910	Periodic Cost	5	$37,500	$37,500	0.854	$32,025
0920	Periodic Cost	10	$22,500	$22,500	0.737	$16,583
0920	Periodic Cost	15	$22,500	$22,500	0.633	$14,243
0920	Periodic Cost	20	$22,500	$22,500	0.543	$12,218
0920	Periodic Cost	25	$22,500	$22,500	0.467	$10,508
0920	Periodic Cost	30	$22,500	$22,500	0.400	$9,000
			$150,000			$94,575
	Total Present Value of Alternative					**$94,575**

AC = acres, EA = each, LS = lump sum, N/A = not applicable, WK = week

AOC No: 3
Alternative No: 1
No Action

CAPITAL COST:

Bid Item No.	Description	QTY	Unit	Team Production (Units/Day)	# Teams	Duration (Weeks)	Weekly Cost Per Team	Total
0100	Work Plans	0.00	LS	N/A	N/A	N/A	80,000	$0
0110	Explosive Safety Submission	0.00	LS	N/A	N/A	N/A	60,000	$0
0200	Mobilization	0.00	LS	N/A	N/A	N/A	36,750	$0
0210	Site-Set-up	0.00	LS	N/A	N/A	N/A	18,098	$0
0300	Site Management	0.00	WEEKS	0.0	0.0	0.0	23,758	$0
0310	Survey/Postioning	0.00	AC	0.0	0.0	0.0	11,810	$0
0320	Brush Clearing	0.00	AC	0.0	0.0	0.0	26,688	$0
0400	Surface MEC Removal	0.00	AC	0.0	0.0	0.0	29,561	$0
0410	Sub-Surface MEC Removal (M&D)	0.00	AC	0.0	0.0	0.0	34,844	$0
0420	Geophysical Mapping	0.00	AC	0.0	0.0	0.0	15,279	$0
0430	Geophysical Data Analysis	0.00	AC	0.0	0.0	0.0	5,875	$0
0440	Anomaly Re-Acquisition	0.00	AC	0.0	0.0	0.0	11,177	$0
0450	Sub-Surface MEC Removal (DGM)	0.00	AC	0.0	0.0	0.0	34,844	$0
0500	MEC Disposal	0.00	AC	0.0	0.0	0.0	22,002	$0
0510	Scrap Disposal	0.00	AC	0.0	0.0	0.0	22,429	$0
0600	Site Restoration	0.00	LS	N/A	N/A	N/A	7,227	$0
0610	Demobilization	0.00	LS	N/A	N/A	N/A	35,750	$0
0700	Final Report	0.00	LS	N/A	N/A	N/A	50,000	$0
0800	Land Use Controls	0.00	LS	N/A	N/A	N/A	86,000	$0
	Sub-Total							$0
	Contingency	15%						$0
	Sub-Total							$0
	Infrastructure Improvements	2%						$0
	Project Management	5%						$0
	Remedial Design (USACE)	8%						$0
	Construction Management (USACE)	6%						$0
	Total Capital Cost							**$0**

ANNUAL O & M COST:

	Description		QTY	Unit	Unit Cost	Total
0900	Land Use Controls - Annual Cost		0	LS	9,500	$0
0910	Construction Support		0	WK	9,021	$0
	Sub-Total					$0
	Contingency	15%				$0
	Total Annual O & M Cost					$0

PERIODIC COST:

	Description	Year	QTY	Unit	Unit Cost	Total
1000	Five Year Review - First Review	5	1	EA	37,500	$37,500
1010	Five Year Review - Years 10,15,20,25 & 30	10 - 30	1	EA	22,500	$22,500

PRESENT VALUE ANALYSIS:

	Cost Type	Year	Total Cost	Total Cost Per Year	Discount Factor (%)	Present Value
	Capitol Cost	0	$0	$0	1	$0
0900	Annual O & M Cost	1 - 30	$0	$0	19.350	$0
0910	Periodic Cost	5	$37,500	$37,500	0.854	$32,025
0920	Periodic Cost	10	$22,500	$22,500	0.737	$16,583
0920	Periodic Cost	15	$22,500	$22,500	0.633	$14,243
0920	Periodic Cost	20	$22,500	$22,500	0.543	$12,218
0920	Periodic Cost	25	$22,500	$22,500	0.467	$10,508
0920	Periodic Cost	30	$22,500	$22,500	0.400	$9,000
			$150,000			$94,575
	Total Present Value of Alternative					**$94,575**

AC = acres, EA = each, LS = lump sum, N/A = not applicable, WK = week

AOC No: 4
Alternative No: 1
No Action

CAPITAL COST:

Bid Item No.	Description	QTY	Unit	Team Production (Units/Day)	# Teams	Duration (Weeks)	Weekly Cost Per Team	Total
0100	Work Plans	0.00	LS	N/A	N/A	N/A	80,000	$0
0110	Explosive Safety Submission	0.00	LS	N/A	N/A	N/A	60,000	$0
0200	Mobilization	0.00	LS	N/A	N/A	N/A	36,750	$0
0210	Site-Set-up	0.00	LS	N/A	N/A	N/A	18,098	$0
0300	Site Management	0.00	WEEKS	0.0	0.0	0.0	23,758	$0
0310	Survey/Postioning	0.00	AC	0.0	0.0	0.0	11,810	$0
0320	Brush Clearing	0.00	AC	0.0	0.0	0.0	16,688	$0
0400	Surface MEC Removal	0.00	AC	0.0	0.0	0.0	29,561	$0
0410	Sub-Surface MEC Removal (M&D)	0.00	AC	0.0	0.0	0.0	34,844	$0
0420	Geophysical Mapping	0.00	AC	0.0	0.0	0.0	15,279	$0
0430	Geophysical Data Analysis	0.00	AC	0.0	0.0	0.0	5,875	$0
0440	Anomaly Re-Acquisition	0.00	AC	0.0	0.0	0.0	11,177	$0
0450	Sub-Surface MEC Removal (DGM)	0.00	AC	0.0	0.0	0.0	34,844	$0
0500	MEC Disposal	0.00	AC	0.0	0.0	0.0	22,002	$0
0510	Scrap Disposal	0.00	AC	0.0	0.0	0.0	22,429	$0
0600	Site Restoration	0.00	LS	N/A	N/A	N/A	7,227	$0
0610	Demobilization	0.00	LS	N/A	N/A	N/A	35,750	$0
0700	Final Report	0.00	LS	N/A	N/A	N/A	50,000	$0
0800	Land Use Controls	0.00	LS	N/A	N/A	N/A	86,000	$0
	Sub-Total							$0
	Contingency	15%						$0
	Sub-Total							$0
	Infrastructure Improvements	2%						$0
	Project Management	5%						$0
	Remedial Design (USACE)	8%						$0
	Construction Management (USACE)	6%						$0
	Total Capital Cost							**$0**

ANNUAL O & M COST:

	Description		QTY	Unit	Unit Cost	Total
0900	Land Use Controls - Annual Cost		0	LS	9,500	$0
0910	Construction Support		0	WK	9,021	$0
	Sub-Total					$0
	Contingency	15%				$0
	Total Annual O & M Cost					$0

PERIODIC COST:

	Description	Year	QTY	Unit	Unit Cost	Total
1000	Five Year Review - First Review	5	1	EA	37,500	$37,500
1010	Five Year Review - Years 10,15,20,25 & 30	10 - 30	1	EA	22,500	$22,500

PRESENT VALUE ANALYSIS:

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0910	Periodic Cost	5	$37,500	$37,500	0.854	$32,025
0920	Periodic Cost	10	$22,500	$22,500	0.737	$16,583
0920	Periodic Cost	15	$22,500	$22,500	0.633	$14,243
0920	Periodic Cost	20	$22,500	$22,500	0.543	$12,218
0920	Periodic Cost	25	$22,500	$22,500	0.467	$10,508
0920	Periodic Cost	30	$22,500	$22,500	0.400	$9,000
			$150,000			$94,575
	Total Present Value of Alternative					**$94,575**

AC = acres, EA = each, LS = lump sum, N/A = not applicable, WK = week

AOC No: 5
Alternative No: 1
No Action

CAPITAL COST:

Bid Item No.	Description	QTY	Unit	Team Production (Units/Day)	# Teams	Duration (Weeks)	Weekly Cost Per Team	Total
0100	Work Plans	0.00	LS	N/A	N/A	N/A	80,000	$0
0110	Explosive Safety Submission	0.00	LS	N/A	N/A	N/A	60,000	$0
0200	Mobilization	0.00	LS	N/A	N/A	N/A	36,750	$0
0210	Site-Set-up	0.00	LS	N/A	N/A	N/A	18,098	$0
0300	Site Management	0.00	WEEKS	0.0	0.0	0.0	23,758	$0
0310	Survey/Postioning	0.00	AC	0.0	0.0	0.0	11,810	$0
0320	Brush Clearing	0.00	AC	0.0	0.0	0.0	26,688	$0
0400	Surface MEC Removal	0.00	AC	0.0	0.0	0.0	29,561	$0
0410	Sub-Surface MEC Removal (M&D)	0.00	AC	0.0	0.0	0.0	34,844	$0
0420	Geophysical Mapping	0.00	AC	0.0	0.0	0.0	15,279	$0
0430	Geophysical Data Analysis	0.00	AC	0.0	0.0	0.0	5,875	$0
0440	Anomaly Re-Acquisition	0.00	AC	0.0	0.0	0.0	11,177	$0
0450	Sub-Surface MEC Removal (DGM)	0.00	AC	0.0	0.0	0.0	34,844	$0
0500	MEC Disposal	0.00	AC	0.0	0.0	0.0	22,002	$0
0510	Scrap Disposal	0.00	AC	0.0	0.0	0.0	22,429	$0
0600	Site Restoration	0.00	LS	N/A	N/A	N/A	7,227	$0
0610	Demobilization	0.00	LS	N/A	N/A	N/A	35,750	$0
0700	Final Report	0.00	LS	N/A	N/A	N/A	50,000	$0
0800	Land Use Controls	0.00	LS	N/A	N/A	N/A	86,000	$0
	Sub-Total							$0
	Contingency	15%						$0
	Sub-Total							$0
	Infrastructure Improvements	2%						$0
	Project Management	5%						$0
	Remedial Design (USACE)	8%						$0
	Construction Management (USACE)	6%						$0
	Total Capital Cost							**$0**

ANNUAL O & M COST:

	Description		QTY	Unit	Unit Cost	Total
0900	Land Use Controls - Annual Cost		0	LS	9,500	$0
0910	Construction Support		0	WK	9,021	$0
	Sub-Total					$0
	Contingency	15%				$0
	Total Annual O & M Cost					$0

PERIODIC COST:

	Description	Year	QTY	Unit	Unit Cost	Total
1000	Five Year Review - First Review	5	1	EA	37,500	$37,500
1010	Five Year Review - Years 10,15,20,25 & 30	10 - 30	1	EA	22,500	$22,500

PRESENT VALUE ANALYSIS:

	Cost Type	Year	Total Cost	Total Cost Per Year	Discount Factor (%)	Present Value
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0900	Annual O & M Cost	1 - 30	$0	$0	19.350	$0
0910	Periodic Cost	5	$37,500	$37,500	0.854	$32,025
0920	Periodic Cost	10	$22,500	$22,500	0.737	$16,583
0920	Periodic Cost	15	$22,500	$22,500	0.633	$14,243
0920	Periodic Cost	20	$22,500	$22,500	0.543	$12,218
0920	Periodic Cost	25	$22,500	$22,500	0.467	$10,508
0920	Periodic Cost	30	$22,500	$22,500	0.400	$9,000
			$150,000			$94,575
Total Present Value of Alternative						**$94,575**

AC = acres, EA = each, LS = lump sum, N/A = not applicable, WK = week

AOC No: 6
Alternative No: 1
No Action

CAPITAL COST:

Bid Item No.	Description	QTY	Unit	Team Production (Units/Day)	# Teams	Duration (Weeks)	Weekly Cost Per Team	Total
0100	Work Plans	0.00	LS	N/A	N/A	N/A	80,000	$0
0110	Explosive Safety Submission	0.00	LS	N/A	N/A	N/A	60,000	$0
0200	Mobilization	0.00	LS	N/A	N/A	N/A	36,750	$0
0210	Site-Set-up	0.00	LS	N/A	N/A	N/A	18,098	$0
0300	Site Management	0.00	WEEKS	0.0	0.0	0.0	23,758	$0
0310	Survey/Postioning	0.00	AC	0.0	0.0	0.0	11,810	$0
0320	Brush Clearing	0.00	AC	0.0	0.0	0.0	26,688	$0
0400	Surface MEC Removal	0.00	AC	0.0	0.0	0.0	29,561	$0
0410	Sub-Surface MEC Removal (M&D)	0.00	AC	0.0	0.0	0.0	34,844	$0
0420	Geophysical Mapping	0.00	AC	0.0	0.0	0.0	15,279	$0
0430	Geophysical Data Analysis	0.00	AC	0.0	0.0	0.0	5,875	$0
0440	Anomaly Re-Acquisition	0.00	AC	0.0	0.0	0.0	11,177	$0
0450	Sub-Surface MEC Removal (DGM)	0.00	AC	0.0	0.0	0.0	34,844	$0
0500	MEC Disposal	0.00	AC	0.0	0.0	0.0	22,002	$0
0510	Scrap Disposal	0.00	AC	0.0	0.0	0.0	22,429	$0
0600	Site Restoration	0.00	LS	N/A	N/A	N/A	7,227	$0
0610	Demobilization	0.00	LS	N/A	N/A	N/A	35,750	$0
0700	Final Report	0.00	LS	N/A	N/A	N/A	50,000	$0
0800	Land Use Controls	0.00	LS	N/A	N/A	N/A	86,000	$0
	Sub-Total							$0
	Contingency	15%						$0
	Sub-Total							$0
	Infrastructure Improvements	2%						$0
	Project Management	5%						$0
	Remedial Design (USACE)	8%						$0
	Construction Management (USACE)	6%						$0
	Total Capital Cost							**$0**

ANNUAL O & M COST:

	Description		QTY	Unit	Unit Cost	Total
0900	Land Use Controls - Annual Cost		0	LS	9,500	$0
0910	Construction Support		0	WK	9,021	$0
	Sub-Total					$0
	Contingency	15%				$0
	Total Annual O & M Cost					$0

PERIODIC COST:

	Description	Year	QTY	Unit	Unit Cost	Total
1000	Five Year Review - First Review	5	1	EA	37,500	$37,500
1010	Five Year Review - Years 10,15,20,25 & 30	10 - 30	1	EA	22,500	$22,500

PRESENT VALUE ANALYSIS:

	Cost Type	Year	Total Cost	Total Cost Per Year	Discount Factor (%)	Present Value
	Capitol Cost	0	$0	$0	1	$0
0900	Annual O & M Cost	1 - 30	$0	$0	19.350	$0
0910	Periodic Cost	5	$37,500	$37,500	0.854	$32,025
0920	Periodic Cost	10	$22,500	$22,500	0.737	$16,583
0920	Periodic Cost	15	$22,500	$22,500	0.633	$14,243
0920	Periodic Cost	20	$22,500	$22,500	0.543	$12,218
0920	Periodic Cost	25	$22,500	$22,500	0.467	$10,508
0920	Periodic Cost	30	$22,500	$22,500	0.400	$9,000
			$150,000			$94,575
	Total Present Value of Alternative					**$94,575**

AC = acres, EA = each, LS = lump sum, N/A = not applicable, WK = week

AOC No: 7
Alternative No: 1
No Action

CAPITAL COST:

Bid Item No.	Description	QTY	Unit	Team Production (Units/Day)	# Teams	Duration (Weeks)	Weekly Cost Per Team	Total
0100	Work Plans	0.00	LS	N/A	N/A	N/A	80,000	$0
0110	Explosive Safety Submission	0.00	LS	N/A	N/A	N/A	60,000	$0
0200	Mobilization	0.00	LS	N/A	N/A	N/A	36,750	$0
0210	Site-Set-up	0.00	LS	N/A	N/A	N/A	18,098	$0
0300	Site Management	0.00	WEEKS	0.0	0.0	0.0	23,758	$0
0310	Survey/Postioning	0.00	AC	0.0	0.0	0.0	11,810	$0
0320	Brush Clearing	0.00	AC	0.0	0.0	0.0	26,688	$0
0400	Surface MEC Removal	0.00	AC	0.0	0.0	0.0	29,561	$0
0410	Sub-Surface MEC Removal (M&D)	0.00	AC	0.0	0.0	0.0	34,844	$0
0420	Geophysical Mapping	0.00	AC	0.0	0.0	0.0	15,279	$0
0430	Geophysical Data Analysis	0.00	AC	0.0	0.0	0.0	5,875	$0
0440	Anomaly Re-Acquisition	0.00	AC	0.0	0.0	0.0	11,177	$0
0450	Sub-Surface MEC Removal (DGM)	0.00	AC	0.0	0.0	0.0	34,844	$0
0500	MEC Disposal	0.00	AC	0.0	0.0	0.0	22,002	$0
0510	Scrap Disposal	0.00	AC	0.0	0.0	0.0	22,429	$0
0600	Site Restoration	0.00	LS	N/A	N/A	N/A	7,227	$0
0610	Demobilization	0.00	LS	N/A	N/A	N/A	35,750	$0
0700	Final Report	0.00	LS	N/A	N/A	N/A	50,000	$0
0800	Land Use Controls	0.00	LS	N/A	N/A	N/A	86,000	$0
	Sub-Total							$0
	Contingency	15%						$0
	Sub-Total							$0
	Infrastructure Improvements	2%						$0
	Project Management	5%						$0
	Remedial Design (USACE)	8%						$0
	Construction Management (USACE)	6%						$0
	Total Capital Cost							**$0**

ANNUAL O & M COST:

	Description		QTY	Unit	Unit Cost	Total
0900	Land Use Controls - Annual Cost		0	LS	9,500	$0
0910	Construction Support		0	WK	9,021	$0
	Sub-Total					$0
	Contingency	15%				$0
	Total Annual O & M Cost					$0

PERIODIC COST:

	Description	Year	QTY	Unit	Unit Cost	Total
1000	Five Year Review - First Review	5	1	EA	37,500	$37,500
1010	Five Year Review - Years 10,15,20,25 & 30	10 - 30	1	EA	22,500	$22,500

PRESENT VALUE ANALYSIS:

	Cost Type	Year	Total Cost	Total Cost Per Year	Discount Factor (%)	Present Value
	Capitol Cost	0	$0	$0	1	$0
0900	Annual O & M Cost	1 - 30	$0	$0	19.350	$0
0910	Periodic Cost	5	$37,500	$37,500	0.854	$32,025
0920	Periodic Cost	10	$22,500	$22,500	0.737	$16,583
0920	Periodic Cost	15	$22,500	$22,500	0.633	$14,243
0920	Periodic Cost	20	$22,500	$22,500	0.543	$12,218
0920	Periodic Cost	25	$22,500	$22,500	0.467	$10,508
0920	Periodic Cost	30	$22,500	$22,500	0.400	$9,000
			$150,000			$94,575
	Total Present Value of Alternative					**$94,575**

AC = acres, EA = each, LS = lump sum, N/A = not applicable, WK = week

AOC No: 8
Alternative No: 1
No Action

CAPITAL COST:

Bid Item No.	Description	QTY	Unit	Team Production (Units/Day)	# Teams	Duration (Weeks)	Weekly Cost Per Team	Total
0100	Work Plans	0.00	LS	N/A	N/A	N/A	80,000	$0
0110	Explosive Safety Submission	0.00	LS	N/A	N/A	N/A	60,000	$0
0200	Mobilization	0.00	LS	N/A	N/A	N/A	36,750	$0
0210	Site-Set-up	0.00	LS	N/A	N/A	N/A	18,098	$0
0300	Site Management	0.00	WEEKS	0.0	0.0	0.0	23,758	$0
0310	Survey/Postioning	0.00	AC	0.0	0.0	0.0	11,810	$0
0320	Brush Clearing	0.00	AC	0.0	0.0	0.0	26,688	$0
0400	Surface MEC Removal	0.00	AC	0.0	0.0	0.0	29,561	$0
0410	Sub-Surface MEC Removal (M&D)	0.00	AC	0.0	0.0	0.0	34,844	$0
0420	Geophysical Mapping	0.00	AC	0.0	0.0	0.0	15,279	$0
0430	Geophysical Data Analysis	0.00	AC	0.0	0.0	0.0	5,875	$0
0440	Anomaly Re-Acquisition	0.00	AC	0.0	0.0	0.0	11,177	$0
0450	Sub-Surface MEC Removal (DGM)	0.00	AC	0.0	0.0	0.0	34,844	$0
0500	MEC Disposal	0.00	AC	0.0	0.0	0.0	22,002	$0
0510	Scrap Disposal	0.00	AC	0.0	0.0	0.0	22,429	$0
0600	Site Restoration	0.00	LS	N/A	N/A	N/A	7,227	$0
0610	Demobilization	0.00	LS	N/A	N/A	N/A	35,750	$0
0700	Final Report	0.00	LS	N/A	N/A	N/A	50,000	$0
0800	Land Use Controls	0.00	LS	N/A	N/A	N/A	86,000	$0
	Sub-Total							$0
	Contingency	15%						$0
	Sub-Total							$0
	Infrastructure Improvements	2%						$0
	Project Management	5%						$0
	Remedial Design (USACE)	8%						$0
	Construction Management (USACE)	6%						$0
	Total Capital Cost							**$0**

ANNUAL O & M COST:

	Description		QTY	Unit	Unit Cost	Total
0900	Land Use Controls - Annual Cost		0	LS	9,500	$0
0910	Construction Support		0	WK	9,021	$0
	Sub-Total					$0
	Contingency	15%				$0
	Total Annual O & M Cost					$0

PERIODIC COST:

	Description	Year	QTY	Unit	Unit Cost	Total
1000	Five Year Review - First Review	5	1	EA	37,500	$37,500
1010	Five Year Review - Years 10,15,20,25 & 30	10 - 30	1	EA	22,500	$22,500

PRESENT VALUE ANALYSIS:

	Cost Type	Year	Total Cost	Total Cost Per Year	Discount Factor (%)	Present Value
	Capitol Cost	0	$0	$0	1	$0
0900	Annual O & M Cost	1 - 30	$0	$0	19.350	$0
0910	Periodic Cost	5	$37,500	$37,500	0.854	$32,025
0920	Periodic Cost	10	$22,500	$22,500	0.737	$16,583
0920	Periodic Cost	15	$22,500	$22,500	0.633	$14,243
0920	Periodic Cost	20	$22,500	$22,500	0.543	$12,218
0920	Periodic Cost	25	$22,500	$22,500	0.467	$10,508
0920	Periodic Cost	30	$22,500	$22,500	0.400	$9,000
			$150,000			$94,575
	Total Present Value of Alternative					**$94,575**

AC = acres, EA = each, LS = lump sum, N/A = not applicable, WK = week

AOC No: 9
Alternative No: 1
No Action

CAPITAL COST:

Bid Item No.	Description	QTY	Unit	Team Production (Units/Day)	# Teams	Duration (Weeks)	Weekly Cost Per Team	Total
0100	Work Plans	0.00	LS	N/A	N/A	N/A	80,000	$0
0110	Explosive Safety Submission	0.00	LS	N/A	N/A	N/A	60,000	$0
0200	Mobilization	0.00	LS	N/A	N/A	N/A	36,750	$0
0210	Site-Set-up	0.00	LS	N/A	N/A	N/A	18,098	$0
0300	Site Management	0.00	WEEKS	0.0	0.0	0.0	23,758	$0
0310	Survey/Postioning	0.00	AC	0.0	0.0	0.0	11,810	$0
0320	Brush Clearing	0.00	AC	0.0	0.0	0.0	26,688	$0
0400	Surface MEC Removal	0.00	AC	0.0	0.0	0.0	29,561	$0
0410	Sub-Surface MEC Removal (M&D)	0.00	AC	0.0	0.0	0.0	34,844	$0
0420	Geophysical Mapping	0.00	AC	0.0	0.0	0.0	15,279	$0
0430	Geophysical Data Analysis	0.00	AC	0.0	0.0	0.0	5,875	$0
0440	Anomaly Re-Acquisition	0.00	AC	0.0	0.0	0.0	11,177	$0
0450	Sub-Surface MEC Removal (DGM)	0.00	AC	0.0	0.0	0.0	34,844	$0
0500	MEC Disposal	0.00	AC	0.0	0.0	0.0	22,002	$0
0510	Scrap Disposal	0.00	AC	0.0	0.0	0.0	22,429	$0
0600	Site Restoration	0.00	LS	N/A	N/A	N/A	7,227	$0
0610	Demobilization	0.00	LS	N/A	N/A	N/A	35,750	$0
0700	Final Report	0.00	LS	N/A	N/A	N/A	50,000	$0
0800	Land Use Controls	0.00	LS	N/A	N/A	N/A	86,000	$0
	Sub-Total							$0
	Contingency	15%						$0
	Sub-Total							$0
	Infrastructure Improvements	2%						$0
	Project Management	5%						$0
	Remedial Design (USACE)	8%						$0
	Construction Management (USACE)	6%						$0
	Total Capital Cost							**$0**

ANNUAL O & M COST:

	Description		QTY	Unit	Unit Cost	Total
0900	Land Use Controls - Annual Cost		0	LS	9,500	$0
0910	Construction Support		0	WK	9,021	$0
	Sub-Total					$0
	Contingency	15%				$0
	Total Annual O & M Cost					$0

PERIODIC COST:

	Description	Year	QTY	Unit	Unit Cost	Total
1000	Five Year Review - First Review	5	1	EA	37,500	$37,500
1010	Five Year Review - Years 10,15,20,25 & 30	10 - 30	1	EA	22,500	$22,500

PRESENT VALUE ANALYSIS:

	Cost Type	Year	Total Cost	Total Cost Per Year	Discount Factor (%)	Present Value
	Capitol Cost	0	$0	$0	1	$0
0900	Annual O & M Cost	1 - 30	$0	$0	19.350	$0
0910	Periodic Cost	5	$37,500	$37,500	0.854	$32,025
0920	Periodic Cost	10	$22,500	$22,500	0.737	$16,583
0920	Periodic Cost	15	$22,500	$22,500	0.633	$14,243
0920	Periodic Cost	20	$22,500	$22,500	0.543	$12,218
0920	Periodic Cost	25	$22,500	$22,500	0.467	$10,508
0920	Periodic Cost	30	$22,500	$22,500	0.400	$9,000
			$150,000			$94,575
	Total Present Value of Alternative					**$94,575**

AC = acres, EA = each, LS = lump sum, N/A = not applicable, WK = week

COST ESTIMATES FOR ALTERNATIVE 2 – LAND USE CONTROLS

AOC No:1
Alternative No: 2
Land Use Controls (LUC)

CAPITAL COST:

Bid Item No.	Description	QTY	Unit	Team Production (Units/Day)	# Teams	Duration (Weeks)	Weekly Cost Per Team	Total
0100	Work Plans	0.00	LS	N/A	N/A	N/A	80,000	$0
0110	Explosive Safety Submission	0.00	LS	N/A	N/A	N/A	60,000	$0
0200	Mobilization	0.00	LS	N/A	N/A	N/A	36,750	$0
0210	Site-Set-up	0.00	LS	N/A	N/A	N/A	18,098	$0
0300	Site Management	0.00	WEEKS	0.0	0.0	0.0	23,758	$0
0310	Survey/Postioning	0.00	AC	0.0	0.0	0.0	11,810	$0
0320	Brush Clearing	0.00	AC	0.0	0.0	0.0	26,688	$0
0400	Surface MEC Removal	0.00	AC	0.0	0.0	0.0	29,561	$0
0410	Sub-Surface MEC Removal (M&D)	0.00	AC	0.0	0.0	0.0	34,844	$0
0420	Geophysical Mapping	0.00	AC	0.0	0.0	0.0	15,279	$0
0430	Geophysical Data Analysis	0.00	AC	0.0	0.0	0.0	5,875	$0
0440	Anomaly Re-Acquisition	0.00	AC	0.0	0.0	0.0	11,177	$0
0450	Sub-Surface MEC Removal (DGM)	0.00	AC	0.0	0.0	0.0	34,844	$0
0500	MEC Disposal	0.00	AC	0.0	0.0	0.0	22,002	$0
0510	Scrap Disposal	0.00	AC	0.0	0.0	0.0	22,429	$0
0600	Site Restoration	0.00	LS	N/A	N/A	N/A	7,227	$0
0610	Demobilization	0.00	LS	N/A	N/A	N/A	35,750	$0
0700	Final Report	0.00	LS	N/A	N/A	N/A	50,000	$0
0800	Land Use Controls	1.00	LS	N/A	N/A	N/A	86,000	$86,000
	Sub-Total							$86,000
	Contingency	15%						$12,900
	Sub-Total							$98,900
	Infrastructure Improvements	2%						$1,978
	Project Management	5%						$4,945
	Remedial Design (USACE)	8%						$7,912
	Construction Management (USACE)	6%						$5,934
	Total Capital Cost							**$119,669**

ANNUAL O & M COST:

	Description		QTY	Unit	Unit Cost	Total
0900	Land Use Controls - Annual Cost		1	LS	9,500	$9,500
0910	Construction Support		4	WK	9,021	$36,084
	Sub-Total					$45,584
	Contingency	15%				$6,838
	Total Annual O & M Cost					$52,422

PERIODIC COST:

	Description	Year	QTY	Unit	Unit Cost	Total
1000	Five Year Review - First Review	5	1	EA	37,500	$37,500
1010	Five Year Review - Years 10,15,20,25 & 30	10 - 30	1	EA	22,500	$22,500

PRESENT VALUE ANALYSIS:

	Cost Type	Year	Total Cost	Total Cost Per Year	Discount Factor (%)	Present Value
	Capitol Cost	0	$119,669	$119,669	1	$119,669
0900	Annual O & M Cost	1 - 30	$1,572,648	$52,422	19.350	$1,014,358
0910	Periodic Cost	5	$37,500	$37,500	0.854	$32,025
0920	Periodic Cost	10	$22,500	$22,500	0.737	$16,583
0920	Periodic Cost	15	$22,500	$22,500	0.633	$14,243
0920	Periodic Cost	20	$22,500	$22,500	0.543	$12,218
0920	Periodic Cost	25	$22,500	$22,500	0.467	$10,508
0920	Periodic Cost	30	$22,500	$22,500	0.400	$9,000
			$1,842,317			$1,228,602
	Total Present Value of Alternative					**$1,228,602**

AC = acres, EA = each, LS = lump sum, N/A = not applicable, WK = week

AOC No:2
Alternative No: 2
Land Use Controls (LUC)

CAPITAL COST:

Bid Item No.	Description	QTY	Unit	Team Production (Units/Day)	# Teams	Duration (Weeks)	Weekly Cost Per Team	Total
0100	Work Plans	0.00	LS	N/A	N/A	N/A	80,000	$0
0110	Explosive Safety Submission	0.00	LS	N/A	N/A	N/A	60,000	$0
0200	Mobilization	0.00	LS	N/A	N/A	N/A	36,750	$0
0210	Site-Set-up	0.00	LS	N/A	N/A	N/A	18,098	$0
0300	Site Management	0.00	WEEKS	0.0	0.0	0.0	23,758	$0
0310	Survey/Postioning	0.00	AC	0.0	0.0	0.0	11,810	$0
0320	Brush Clearing	0.00	AC	0.0	0.0	0.0	26,688	$0
0400	Surface MEC Removal	0.00	AC	0.0	0.0	0.0	29,561	$0
0410	Sub-Surface MEC Removal (M&D)	0.00	AC	0.0	0.0	0.0	34,844	$0
0420	Geophysical Mapping	0.00	AC	0.0	0.0	0.0	15,279	$0
0430	Geophysical Data Analysis	0.00	AC	0.0	0.0	0.0	5,875	$0
0440	Anomaly Re-Acquisition	0.00	AC	0.0	0.0	0.0	11,177	$0
0450	Sub-Surface MEC Removal (DGM)	0.00	AC	0.0	0.0	0.0	34,844	$0
0500	MEC Disposal	0.00	AC	0.0	0.0	0.0	22,002	$0
0510	Scrap Disposal	0.00	AC	0.0	0.0	0.0	22,429	$0
0600	Site Restoration	0.00	LS	N/A	N/A	N/A	7,227	$0
0610	Demobilization	0.00	LS	N/A	N/A	N/A	35,750	$0
0700	Final Report	0.00	LS	N/A	N/A	N/A	50,000	$0
0800	Land Use Controls	1.00	LS	N/A	N/A	N/A	86,000	$86,000
	Sub-Total							$86,000
	Contingency	15%						$12,900
	Sub-Total							$98,900
	Infrastructure Improvements	2%						$1,978
	Project Management	5%						$4,945
	Remedial Design (USACE)	8%						$7,912
	Construction Management (USACE)	6%						$5,934
	Total Capital Cost							**$119,669**

ANNUAL O & M COST:

	Description		QTY	Unit	Unit Cost	Total
0900	Land Use Controls - Annual Cost		1	LS	9,500	$9,500
0910	Construction Support		4	WK	9,021	$36,084
	Sub-Total					$45,584
	Contingency	15%				$6,838
	Total Annual O & M Cost					$52,422

PERIODIC COST:

	Description	Year	QTY	Unit	Unit Cost	Total
1000	Five Year Review - First Review	5	1	EA	37,500	$37,500
1010	Five Year Review - Years 10,15,20,25 & 30	10 - 30	1	EA	22,500	$22,500

PRESENT VALUE ANALYSIS:

	Cost Type	Year	Total Cost	Total Cost Per Year	Discount Factor (%)	Present Value
	Capitol Cost	0	$119,669.00	$119,669.00	1	$119,669
0900	Annual O & M Cost	1 - 30	$1,572,648	$52,422	19.350	$1,014,358
0910	Periodic Cost	5	$37,500	$37,500	0.854	$32,025
0920	Periodic Cost	10	$22,500	$22,500	0.737	$16,583
0920	Periodic Cost	15	$22,500	$22,500	0.633	$14,243
0920	Periodic Cost	20	$22,500	$22,500	0.543	$12,218
0920	Periodic Cost	25	$22,500	$22,500	0.467	$10,508
0920	Periodic Cost	30	$22,500	$22,500	0.400	$9,000
			$1,842,317			$1,228,602
	Total Present Value of Alternative					**$1,228,602**

AC = acres, EA = each, LS = lump sum, N/A = not applicable, WK = week

AOC No: 3
Alternative No: 2
Land Use Controls (LUC)

CAPITAL COST:

Bid Item No.	Description	QTY	Unit	Team Production (Units/Day)	# Teams	Duration (Weeks)	Weekly Cost Per Team	Total
0100	Work Plans	0.00	LS	N/A	N/A	N/A	80,000	$0
0110	Explosive Safety Submission	0.00	LS	N/A	N/A	N/A	60,000	$0
0200	Mobilization	0.00	LS	N/A	N/A	N/A	36,750	$0
0210	Site-Set-up	0.00	LS	N/A	N/A	N/A	18,098	$0
0300	Site Management	0.00	WEEKS	0.0	0.0	0.0	23,758	$0
0310	Survey/Postioning	0.00	AC	0.0	0.0	0.0	11,810	$0
0320	Brush Clearing	0.00	AC	0.0	0.0	0.0	26,688	$0
0400	Surface MEC Removal	0.00	AC	0.0	0.0	0.0	29,561	$0
0410	Sub-Surface MEC Removal (M&D)	0.00	AC	0.0	0.0	0.0	34,844	$0
0420	Geophysical Mapping	0.00	AC	0.0	0.0	0.0	15,279	$0
0430	Geophysical Data Analysis	0.00	AC	0.0	0.0	0.0	5,875	$0
0440	Anomaly Re-Acquisition	0.00	AC	0.0	0.0	0.0	11,177	$0
0450	Sub-Surface MEC Removal (DGM)	0.00	AC	0.0	0.0	0.0	34,844	$0
0500	MEC Disposal	0.00	AC	0.0	0.0	0.0	22,002	$0
0510	Scrap Disposal	0.00	AC	0.0	0.0	0.0	22,429	$0
0600	Site Restoration	0.00	LS	N/A	N/A	N/A	7,227	$0
0610	Demobilization	0.00	LS	N/A	N/A	N/A	35,750	$0
0700	Final Report	0.00	LS	N/A	N/A	N/A	50,000	$0
0800	Land Use Controls	1.00	LS	N/A	N/A	N/A	86,000	$86,000
	Sub-Total							$86,000
	Contingency	15%						$12,900
	Sub-Total							$98,900
	Infrastructure Improvements	2%						$1,978
	Project Management	5%						$4,945
	Remedial Design (USACE)	8%						$7,912
	Construction Management (USACE)	6%						$5,934
	Total Capital Cost							**$119,669**

ANNUAL O & M COST:

	Description		QTY	Unit	Unit Cost	Total
0900	Land Use Controls - Annual Cost		1	LS	9,500	$9,500
0910	Construction Support		4	WK	9,021	$36,084
	Sub-Total					$45,584
	Contingency	15%				$6,838
	Total Annual O & M Cost					$52,422

PERIODIC COST:

	Description	Year	QTY	Unit	Unit Cost	Total
1000	Five Year Review - First Review	5	1	EA	37,500	$37,500
1010	Five Year Review - Years 10,15,20,25 & 30	10 - 30	1	EA	22,500	$22,500

PRESENT VALUE ANALYSIS:

	Cost Type	Year	Total Cost	Total Cost Per Year	Discount Factor (%)	Present Value
	Capitol Cost	0	$119,669	$119,669	1	$119,669
0900	Annual O & M Cost	1 - 30	$1,572,648	$52,422	19.350	$1,014,358
0910	Periodic Cost	5	$37,500	$37,500	0.854	$32,025
0920	Periodic Cost	10	$22,500	$22,500	0.737	$16,583
0920	Periodic Cost	15	$22,500	$22,500	0.633	$14,243
0920	Periodic Cost	20	$22,500	$22,500	0.543	$12,218
0920	Periodic Cost	25	$22,500	$22,500	0.467	$10,508
0920	Periodic Cost	30	$22,500	$22,500	0.400	$9,000
			$1,842,317			$1,228,602
	Total Present Value of Alternative					**$1,228,602**

AC = acres, EA = each, LS = lump sum, N/A = not applicable, WK = week

AOC No: 4
Alternative No: 2
Land Use Controls (LUC)

CAPITAL COST:

Bid Item No.	Description	QTY	Unit	Team Production (Units/Day)	# Teams	Duration (Weeks)	Weekly Cost Per Team	Total
0100	Work Plans	0.00	LS	N/A	N/A	N/A	80,000	$0
0110	Explosive Safety Submission	0.00	LS	N/A	N/A	N/A	60,000	$0
0200	Mobilization	0.00	LS	N/A	N/A	N/A	36,750	$0
0210	Site-Set-up	0.00	LS	N/A	N/A	N/A	18,098	$0
0300	Site Management	0.00	WEEKS	0.0	0.0	0.0	23,758	$0
0310	Survey/Postioning	0.00	AC	0.0	0.0	0.0	11,810	$0
0320	Brush Clearing	0.00	AC	0.0	0.0	0.0	16,688	$0
0400	Surface MEC Removal	0.00	AC	0.0	0.0	0.0	29,561	$0
0410	Sub-Surface MEC Removal (M&D)	0.00	AC	0.0	0.0	0.0	34,844	$0
0420	Geophysical Mapping	0.00	AC	0.0	0.0	0.0	15,279	$0
0430	Geophysical Data Analysis	0.00	AC	0.0	0.0	0.0	5,875	$0
0440	Anomaly Re-Acquisition	0.00	AC	0.0	0.0	0.0	11,177	$0
0450	Sub-Surface MEC Removal (DGM)	0.00	AC	0.0	0.0	0.0	34,844	$0
0500	MEC Disposal	0.00	AC	0.0	0.0	0.0	22,002	$0
0510	Scrap Disposal	0.00	AC	0.0	0.0	0.0	22,429	$0
0600	Site Restoration	0.00	LS	N/A	N/A	N/A	7,227	$0
0610	Demobilization	0.00	LS	N/A	N/A	N/A	35,750	$0
0700	Final Report	0.00	LS	N/A	N/A	N/A	50,000	$0
0800	Land Use Controls	1.00	LS	N/A	N/A	N/A	86,000	$86,000
	Sub-Total							$86,000
	Contingency	15%						$12,900
	Sub-Total							$98,900
	Infrastructure Improvements	2%						$1,978
	Project Management	5%						$4,945
	Remedial Design (USACE)	8%						$7,912
	Construction Management (USACE)	6%						$5,934
	Total Capital Cost							**$119,669**

ANNUAL O & M COST:

	Description		QTY	Unit	Unit Cost	Total
0900	Land Use Controls - Annual Cost		1	LS	9,500	$9,500
0910	Construction Support		4	WK	9,021	$36,084
	Sub-Total					$45,584
	Contingency	15%				$6,838
	Total Annual O & M Cost					$52,422

PERIODIC COST:

	Description	Year	QTY	Unit	Unit Cost	Total
1000	Five Year Review - First Review	5	1	EA	37,500	$37,500
1010	Five Year Review - Years 10,15,20,25 & 30	10 - 30	1	EA	22,500	$22,500

PRESENT VALUE ANALYSIS:

	Cost Type	Year	Total Cost	Total Cost Per Year	Discount Factor (%)	Present Value
	Capitol Cost	0	$119,669	$119,669	1	$119,669
0900	Annual O & M Cost	1 - 30	$1,572,648	$52,422	19.350	$1,014,358
0910	Periodic Cost	5	$37,500	$37,500	0.854	$32,025
0920	Periodic Cost	10	$22,500	$22,500	0.737	$16,583
0920	Periodic Cost	15	$22,500	$22,500	0.633	$14,243
0920	Periodic Cost	20	$22,500	$22,500	0.543	$12,218
0920	Periodic Cost	25	$22,500	$22,500	0.467	$10,508
0920	Periodic Cost	30	$22,500	$22,500	0.400	$9,000
			$1,842,317			$1,228,602
	Total Present Value of Alternative					**$1,228,602**

AC = acres, EA = each, LS = lump sum, N/A = not applicable, WK = week

AOC No: 5
Alternative No: 2
Land Use Controls (LUC)

CAPITAL COST:

Bid Item No.	Description	QTY	Unit	Team Production (Units/Day)	# Teams	Duration (Weeks)	Weekly Cost Per Team	Total
0100	Work Plans	0.00	LS	N/A	N/A	N/A	80,000	$0
0110	Explosive Safety Submission	0.00	LS	N/A	N/A	N/A	60,000	$0
0200	Mobilization	0.00	LS	N/A	N/A	N/A	36,750	$0
0210	Site-Set-up	0.00	LS	N/A	N/A	N/A	18,098	$0
0300	Site Management	0.00	WEEKS	0.0	0.0	0.0	23,758	$0
0310	Survey/Postioning	0.00	AC	0.0	0.0	0.0	11,810	$0
0320	Brush Clearing	0.00	AC	0.0	0.0	0.0	26,688	$0
0400	Surface MEC Removal	0.00	AC	0.0	0.0	0.0	29,561	$0
0410	Sub-Surface MEC Removal (M&D)	0.00	AC	0.0	0.0	0.0	34,844	$0
0420	Geophysical Mapping	0.00	AC	0.0	0.0	0.0	15,279	$0
0430	Geophysical Data Analysis	0.00	AC	0.0	0.0	0.0	5,875	$0
0440	Anomaly Re-Acquisition	0.00	AC	0.0	0.0	0.0	11,177	$0
0450	Sub-Surface MEC Removal (DGM)	0.00	AC	0.0	0.0	0.0	34,844	$0
0500	MEC Disposal	0.00	AC	0.0	0.0	0.0	22,002	$0
0510	Scrap Disposal	0.00	AC	0.0	0.0	0.0	22,429	$0
0600	Site Restoration	0.00	LS	N/A	N/A	N/A	7,227	$0
0610	Demobilization	0.00	LS	N/A	N/A	N/A	35,750	$0
0700	Final Report	0.00	LS	N/A	N/A	N/A	50,000	$0
0800	Land Use Controls	1.00	LS	N/A	N/A	N/A	86,000	$86,000
	Sub-Total							$86,000
	Contingency	15%						$12,900
	Sub-Total							$98,900
	Infrastructure Improvements	2%						$1,978
	Project Management	5%						$4,945
	Remedial Design (USACE)	8%						$7,912
	Construction Management (USACE)	6%						$5,934
	Total Capital Cost							**$119,669**

ANNUAL O & M COST:

	Description		QTY	Unit	Unit Cost	Total
0900	Land Use Controls - Annual Cost		1	LS	9,500	$9,500
0910	Construction Support		4	WK	9,021	$36,084
	Sub-Total					$45,584
	Contingency	15%				$6,838
	Total Annual O & M Cost					$52,422

PERIODIC COST:

	Description	Year	QTY	Unit	Unit Cost	Total
1000	Five Year Review - First Review	5	1	EA	37,500	$37,500
1010	Five Year Review - Years 10,15,20,25 & 30	10 - 30	1	EA	22,500	$22,500

PRESENT VALUE ANALYSIS:

	Cost Type	Year	Total Cost	Total Cost Per Year	Discount Factor (%)	Present Value
	Capitol Cost	0	$119,669	$119,669	1	$119,669
0900	Annual O & M Cost	1 - 30	$1,572,648	$52,422	19.350	$1,014,358
0910	Periodic Cost	5	$37,500	$37,500	0.854	$32,025
0920	Periodic Cost	10	$22,500	$22,500	0.737	$16,583
0920	Periodic Cost	15	$22,500	$22,500	0.633	$14,243
0920	Periodic Cost	20	$22,500	$22,500	0.543	$12,218
0920	Periodic Cost	25	$22,500	$22,500	0.467	$10,508
0920	Periodic Cost	30	$22,500	$22,500	0.400	$9,000
			$1,842,317			$1,228,602
	Total Present Value of Alternative					**$1,228,602**

AC = acres, EA = each, LS = lump sum, N/A = not applicable, WK = week

AOC No: 6
Alternative No: 2
Land Use Controls (LUC)

CAPITAL COST:

Bid Item No.	Description	QTY	Unit	Team Production (Units/Day)	# Teams	Duration (Weeks)	Weekly Cost Per Team	Total
0100	Work Plans	0.00	LS	N/A	N/A	N/A	80,000	$0
0110	Explosive Safety Submission	0.00	LS	N/A	N/A	N/A	60,000	$0
0200	Mobilization	0.00	LS	N/A	N/A	N/A	36,750	$0
0210	Site-Set-up	0.00	LS	N/A	N/A	N/A	18,098	$0
0300	Site Management	0.00	WEEKS	0.0	0.0	0.0	23,758	$0
0310	Survey/Postioning	0.00	AC	0.0	0.0	0.0	11,810	$0
0320	Brush Clearing	0.00	AC	0.0	0.0	0.0	26,688	$0
0400	Surface MEC Removal	0.00	AC	0.0	0.0	0.0	29,561	$0
0410	Sub-Surface MEC Removal (M&D)	0.00	AC	0.0	0.0	0.0	34,844	$0
0420	Geophysical Mapping	0.00	AC	0.0	0.0	0.0	15,279	$0
0430	Geophysical Data Analysis	0.00	AC	0.0	0.0	0.0	5,875	$0
0440	Anomaly Re-Acquisition	0.00	AC	0.0	0.0	0.0	11,177	$0
0450	Sub-Surface MEC Removal (DGM)	0.00	AC	0.0	0.0	0.0	34,844	$0
0500	MEC Disposal	0.00	AC	0.0	0.0	0.0	22,002	$0
0510	Scrap Disposal	0.00	AC	0.0	0.0	0.0	22,429	$0
0600	Site Restoration	0.00	LS	N/A	N/A	N/A	7,227	$0
0610	Demobilization	0.00	LS	N/A	N/A	N/A	35,750	$0
0700	Final Report	0.00	LS	N/A	N/A	N/A	50,000	$0
0800	Land Use Controls	1.00	LS	N/A	N/A	N/A	86,000	$86,000
	Sub-Total							$86,000
	Contingency	15%						$12,900
	Sub-Total							$98,900
	Infrastructure Improvements	2%						$1,978
	Project Management	5%						$4,945
	Remedial Design (USACE)	8%						$7,912
	Construction Management (USACE)	6%						$5,934
	Total Capital Cost							**$119,669**

ANNUAL O & M COST:

	Description		QTY	Unit	Unit Cost	Total
0900	Land Use Controls - Annual Cost		1	LS	9,500	$9,500
0910	Construction Support		1	WK	9,021	$9,021
	Sub-Total					$18,521
	Contingency	15%				$2,778
	Total Annual O & M Cost					$21,299

PERIODIC COST:

	Description	Year	QTY	Unit	Unit Cost	Total
1000	Five Year Review - First Review	5	1	EA	37,500	$37,500
1010	Five Year Review - Years 10,15,20,25 & 30	10 - 30	1	EA	22,500	$22,500

PRESENT VALUE ANALYSIS:

	Cost Type	Year	Total Cost	Total Cost Per Year	Discount Factor (%)	Present Value
	Capitol Cost	0	$119,669	$119,669	1	$119,669
0900	Annual O & M Cost	1 - 30	$638,975	$21,299	19.350	$412,139
0910	Periodic Cost	5	$37,500	$37,500	0.854	$32,025
0920	Periodic Cost	10	$22,500	$22,500	0.737	$16,583
0920	Periodic Cost	15	$22,500	$22,500	0.633	$14,243
0920	Periodic Cost	20	$22,500	$22,500	0.543	$12,218
0920	Periodic Cost	25	$22,500	$22,500	0.467	$10,508
0920	Periodic Cost	30	$22,500	$22,500	0.400	$9,000
			$908,644			$626,383
	Total Present Value of Alternative					**$626,383**

AC = acres, EA = each, LS = lump sum, N/A = not applicable, WK = week

AOC No: 7
Alternative No: 2
Land Use Controls (LUC)

CAPITAL COST:

Bid Item No.	Description	QTY	Unit	Team Production (Units/Day)	# Teams	Duration (Weeks)	Weekly Cost Per Team	Total
0100	Work Plans	0.00	LS	N/A	N/A	N/A	80,000	$0
0110	Explosive Safety Submission	0.00	LS	N/A	N/A	N/A	60,000	$0
0200	Mobilization	0.00	LS	N/A	N/A	N/A	36,750	$0
0210	Site-Set-up	0.00	LS	N/A	N/A	N/A	18,098	$0
0300	Site Management	0.00	WEEKS	0.0	0.0	0.0	23,758	$0
0310	Survey/Postioning	0.00	AC	0.0	0.0	0.0	11,810	$0
0320	Brush Clearing	0.00	AC	0.0	0.0	0.0	26,688	$0
0400	Surface MEC Removal	0.00	AC	0.0	0.0	0.0	29,561	$0
0410	Sub-Surface MEC Removal (M&D)	0.00	AC	0.0	0.0	0.0	34,844	$0
0420	Geophysical Mapping	0.00	AC	0.0	0.0	0.0	15,279	$0
0430	Geophysical Data Analysis	0.00	AC	0.0	0.0	0.0	5,875	$0
0440	Anomaly Re-Acquisition	0.00	AC	0.0	0.0	0.0	11,177	$0
0450	Sub-Surface MEC Removal (DGM)	0.00	AC	0.0	0.0	0.0	34,844	$0
0500	MEC Disposal	0.00	AC	0.0	0.0	0.0	22,002	$0
0510	Scrap Disposal	0.00	AC	0.0	0.0	0.0	22,429	$0
0600	Site Restoration	0.00	LS	N/A	N/A	N/A	7,227	$0
0610	Demobilization	0.00	LS	N/A	N/A	N/A	35,750	$0
0700	Final Report	0.00	LS	N/A	N/A	N/A	50,000	$0
0800	Land Use Controls	1.00	LS	N/A	N/A	N/A	86,000	$86,000
	Sub-Total							$86,000
	Contingency	15%						$12,900
	Sub-Total							$98,900
	Infrastructure Improvements	2%						$1,978
	Project Management	5%						$4,945
	Remedial Design (USACE)	8%						$7,912
	Construction Management (USACE)	6%						$5,934
	Total Capital Cost							**$119,669**

ANNUAL O & M COST:

	Description		QTY	Unit	Unit Cost	Total
0900	Land Use Controls - Annual Cost		1	LS	9,500	$9,500
0910	Construction Support		1	WK	9,021	$9,021
	Sub-Total					$18,521
	Contingency	15%				$2,778
	Total Annual O & M Cost					$21,299

PERIODIC COST:

	Description	Year	QTY	Unit	Unit Cost	Total
1000	Five Year Review - First Review	5	1	EA	37,500	$37,500
1010	Five Year Review - Years 10,15,20,25 & 30	10 - 30	1	EA	22,500	$22,500

PRESENT VALUE ANALYSIS:

	Cost Type	Year	Total Cost	Total Cost Per Year	Discount Factor (%)	Present Value
	Capitol Cost	0	$119,669	$119,669	1	$119,669
0900	Annual O & M Cost	1 - 30	$638,975	$21,299	19.350	$412,139
0910	Periodic Cost	5	$37,500	$37,500	0.854	$32,025
0920	Periodic Cost	10	$22,500	$22,500	0.737	$16,583
0920	Periodic Cost	15	$22,500	$22,500	0.633	$14,243
0920	Periodic Cost	20	$22,500	$22,500	0.543	$12,218
0920	Periodic Cost	25	$22,500	$22,500	0.467	$10,508
0920	Periodic Cost	30	$22,500	$22,500	0.400	$9,000
			$908,644			$626,383
	Total Present Value of Alternative					**$626,383**

AC = acres, EA = each, LS = lump sum, N/A = not applicable, WK = week

AOC No: 8
Alternative No: 2
Land Use Controls (LUC)

CAPITAL COST:

Bid Item No.	Description	QTY	Unit	Team Production (Units/Day)	# Teams	Duration (Weeks)	Weekly Cost Per Team	Total
0100	Work Plans	0.00	LS	N/A	N/A	N/A	80,000	$0
0110	Explosive Safety Submission	0.00	LS	N/A	N/A	N/A	60,000	$0
0200	Mobilization	0.00	LS	N/A	N/A	N/A	36,750	$0
0210	Site-Set-up	0.00	LS	N/A	N/A	N/A	18,098	$0
0300	Site Management	0.00	WEEKS	0.0	0.0	0.0	23,758	$0
0310	Survey/Postioning	0.00	AC	0.0	0.0	0.0	11,810	$0
0320	Brush Clearing	0.00	AC	0.0	0.0	0.0	26,688	$0
0400	Surface MEC Removal	0.00	AC	0.0	0.0	0.0	29,561	$0
0410	Sub-Surface MEC Removal (M&D)	0.00	AC	0.0	0.0	0.0	34,844	$0
0420	Geophysical Mapping	0.00	AC	0.0	0.0	0.0	15,279	$0
0430	Geophysical Data Analysis	0.00	AC	0.0	0.0	0.0	5,875	$0
0440	Anomaly Re-Acquisition	0.00	AC	0.0	0.0	0.0	11,177	$0
0450	Sub-Surface MEC Removal (DGM)	0.00	AC	0.0	0.0	0.0	34,844	$0
0500	MEC Disposal	0.00	AC	0.0	0.0	0.0	22,002	$0
0510	Scrap Disposal	0.00	AC	0.0	0.0	0.0	22,429	$0
0600	Site Restoration	0.00	LS	N/A	N/A	N/A	7,227	$0
0610	Demobilization	0.00	LS	N/A	N/A	N/A	35,750	$0
0700	Final Report	0.00	LS	N/A	N/A	N/A	50,000	$0
0800	Land Use Controls	1.00	LS	N/A	N/A	N/A	86,000	$86,000
	Sub-Total							$86,000
	Contingency	15%						$12,900
	Sub-Total							$98,900
	Infrastructure Improvements	2%						$1,978
	Project Management	5%						$4,945
	Remedial Design (USACE)	8%						$7,912
	Construction Management (USACE)	6%						$5,934
	Total Capital Cost							**$119,669**

ANNUAL O & M COST:

	Description		QTY	Unit	Unit Cost	Total
0900	Land Use Controls - Annual Cost		1	LS	9,500	$9,500
0910	Construction Support		1	WK	9,021	$9,021
	Sub-Total					$18,521
	Contingency	15%				$2,778
	Total Annual O & M Cost					$21,299

PERIODIC COST:

	Description	Year	QTY	Unit	Unit Cost	Total
1000	Five Year Review - First Review	5	1	EA	37,500	$37,500
1010	Five Year Review - Years 10,15,20,25 & 30	10 - 30	1	EA	22,500	$22,500

PRESENT VALUE ANALYSIS:

	Cost Type	Year	Total Cost	Total Cost Per Year	Discount Factor (%)	Present Value
	Capitol Cost	0	$119,669	$119,669	1	$119,669
0900	Annual O & M Cost	1 - 30	$638,975	$21,299	19.350	$412,139
0910	Periodic Cost	5	$37,500	$37,500	0.854	$32,025
0920	Periodic Cost	10	$22,500	$22,500	0.737	$16,583
0920	Periodic Cost	15	$22,500	$22,500	0.633	$14,243
0920	Periodic Cost	20	$22,500	$22,500	0.543	$12,218
0920	Periodic Cost	25	$22,500	$22,500	0.467	$10,508
0920	Periodic Cost	30	$22,500	$22,500	0.400	$9,000
			$908,644			$626,383
	Total Present Value of Alternative					**$626,383**

AC = acres, EA = each, LS = lump sum, N/A = not applicable, WK = week

AOC No: 9
Alternative No: 2
Land Use Controls (LUC)

CAPITAL COST:

Bid Item No.	Description	QTY	Unit	Team Production (Units/Day)	# Teams	Duration (Weeks)	Weekly Cost Per Team	Total
0100	Work Plans	0.00	LS	N/A	N/A	N/A	80,000	$0
0110	Explosive Safety Submission	0.00	LS	N/A	N/A	N/A	60,000	$0
0200	Mobilization	0.00	LS	N/A	N/A	N/A	36,750	$0
0210	Site-Set-up	0.00	LS	N/A	N/A	N/A	18,098	$0
0300	Site Management	0.00	WEEKS	0.0	0.0	0.0	23,758	$0
0310	Survey/Postioning	0.00	AC	0.0	0.0	0.0	11,810	$0
0320	Brush Clearing	0.00	AC	0.0	0.0	0.0	26,688	$0
0400	Surface MEC Removal	0.00	AC	0.0	0.0	0.0	29,561	$0
0410	Sub-Surface MEC Removal (M&D)	0.00	AC	0.0	0.0	0.0	34,844	$0
0420	Geophysical Mapping	0.00	AC	0.0	0.0	0.0	15,279	$0
0430	Geophysical Data Analysis	0.00	AC	0.0	0.0	0.0	5,875	$0
0440	Anomaly Re-Acquisition	0.00	AC	0.0	0.0	0.0	11,177	$0
0450	Sub-Surface MEC Removal (DGM)	0.00	AC	0.0	0.0	0.0	34,844	$0
0500	MEC Disposal	0.00	AC	0.0	0.0	0.0	22,002	$0
0510	Scrap Disposal	0.00	AC	0.0	0.0	0.0	22,429	$0
0600	Site Restoration	0.00	LS	N/A	N/A	N/A	7,227	$0
0610	Demobilization	0.00	LS	N/A	N/A	N/A	35,750	$0
0700	Final Report	0.00	LS	N/A	N/A	N/A	50,000	$0
0800	Land Use Controls	1.00	LS	N/A	N/A	N/A	86,000	$86,000
	Sub-Total							$86,000
	Contingency	15%						$12,900
	Sub-Total							$98,900
	Infrastructure Improvements	2%						$1,978
	Project Management	5%						$4,945
	Remedial Design (USACE)	8%						$7,912
	Construction Management (USACE)	6%						$5,934
	Total Capital Cost							**$119,669**

ANNUAL O & M COST:

	Description		QTY	Unit	Unit Cost	Total
0900	Land Use Controls - Annual Cost		1	LS	9,500	$9,500
0910	Construction Support		1	WK	9,021	$9,021
	Sub-Total					$18,521
	Contingency	15%				$2,778
	Total Annual O & M Cost					$21,299

PERIODIC COST:

	Description	Year	QTY	Unit	Unit Cost	Total
1000	Five Year Review - First Review	5	1	EA	37,500	$37,500
1010	Five Year Review - Years 10,15,20,25 & 30	10 - 30	1	EA	22,500	$22,500

PRESENT VALUE ANALYSIS:

	Cost Type	Year	Total Cost	Total Cost Per Year	Discount Factor (%)	Present Value
	Capitol Cost	0	$119,669	$119,669	1	$119,669
0900	Annual O & M Cost	1 - 30	$638,975	$21,299	19.350	$412,139
0910	Periodic Cost	5	$37,500	$37,500	0.854	$32,025
0920	Periodic Cost	10	$22,500	$22,500	0.737	$16,583
0920	Periodic Cost	15	$22,500	$22,500	0.633	$14,243
0920	Periodic Cost	20	$22,500	$22,500	0.543	$12,218
0920	Periodic Cost	25	$22,500	$22,500	0.467	$10,508
0920	Periodic Cost	30	$22,500	$22,500	0.400	$9,000
			$908,644			$626,383
	Total Present Value of Alternative					**$626,383**

AC = acres, EA = each, LS = lump sum, N/A = not applicable, WK = week

COST ESTIMATES FOR ALTERNATIVE 3 –

SURFACE REMOVAL OF UXO WITH LAND USE CONTROLS

AOC No: 1
Alternative No: 3
Surface Removal of MEC with Land Use Controls

CAPITAL COST:

Bid Item No.	Description	QTY	Unit	Team Production (Units/Day)	# Teams	Duration (Weeks)	Weekly Cost Per Team	Total
0100	Work Plans	1.00	LS	N/A	N/A	N/A	80,000	$80,000
0110	Explosive Safety Submission	1.00	LS	N/A	N/A	N/A	60,000	$60,000
0200	Mobilization	1.00	LS	N/A	N/A	N/A	36,750	$36,750
0210	Site-Set-up	1.00	LS	N/A	N/A	N/A	18,098	$18,098
0300	Site Management	12.33	WEEKS	1.00	1	12.33	23,758	$292,910
0310	Survey/Postioning	166.00	AC	12.00	1	2.77	11,810	$32,674
0320	Brush Clearing	166.00	AC	1.50	4	5.53	26,688	$590,694
0400	Surface MEC Removal	166.00	AC	3.00	3	3.69	29,561	$327,142
0410	Sub-Surface MEC Removal (M&D)	0.00	AC	1.40	2	0.00	34,844	$0
0420	Geophysical Mapping	0.00	AC	2.00	2	0.00	15,279	$0
0430	Geophysical Data Analysis	0.00	AC	3.00	2	0.00	5,875	$0
0440	Anomaly Re-Acquisition	0.00	AC	2.00	2	0.00	11,177	$0
0450	Sub-Surface MEC Removal (DGM Picks)	0.00	AC	2.00	2	0.00	34,844	$0
0500	MEC Disposal	166.00	AC	10.00	3	1.11	22,002	$73,047
0510	Scrap Disposal	166.00	AC	30.00	3	0.37	22,429	$24,821
0600	Site Restoration	166.00	AC	30.00	1	1.11	7,227	$7,998
0610	Demobilization	1.00	LS	N/A	N/A	N/A	35,750	$35,750
0700	Final Report	1.00	LS	N/A	N/A	N/A	50,000	$50,000
0800	Land Use Controls	1.00	LS	N/A	N/A	N/A	86,000	$86,000
	Sub-Total							$1,715,884
	Contingency	15%						$257,383
	Sub-Total							$1,973,267
	Infrastructure Improvements	2%						$39,465
	Project Management	5%						$98,663
	Remedial Design (USACE)	8%						$157,861
	Construction Management (USACE)	6%						$118,396
	Total Capital Cost							**$2,387,653**

ANNUAL O & M COST:

	Description		QTY	Unit	Unit Cost	Total
0900	Land Use Controls - Annual Cost		1	LS	9,500	$9,500
0910	Construction Support		4	WK	9,021	$36,084
	Sub-Total					$45,584
	Contingency	15%				$6,838
	Total Annual O & M Cost					$52,422

PERIODIC COST:

	Description	Year	QTY	Unit	Unit Cost	Total
1000	Five Year Review - First Review	5	1	EA	37,500	$37,500
1010	Five Year Review - Years 10,15,20,25 & 30	10 - 30	1	EA	22,500	$22,500

PRESENT VALUE ANALYSIS:

	Cost Type	Year	Total Cost	Total Cost Per Year	Discount Factor (%)	Present Value
	Capitol Cost	0	$2,387,653	$2,387,653	1	$2,387,653
0900	Annual O & M Cost	1 - 30	$1,572,648	$52,422	19.350	$1,014,358
0910	Periodic Cost	5	$37,500	$37,500	0.854	$32,025
0920	Periodic Cost	10	$22,500	$22,500	0.737	$16,583
0920	Periodic Cost	15	$22,500	$22,500	0.633	$14,243
0920	Periodic Cost	20	$22,500	$22,500	0.543	$12,218
0920	Periodic Cost	25	$22,500	$22,500	0.467	$10,508
0920	Periodic Cost	30	$22,500	$22,500	0.400	$9,000
			$4,110,301			$3,496,586
	Total Present Value of Alternative					**$3,496,586**

AC = acres, EA = each, LS = lump sum, N/A = not applicable, WK = week

AOC No: 2
Alternative No: 3
Surface Removal of MEC with Land Use Controls

CAPITAL COST:

Bid Item No.	Description	QTY	Unit	Team Production (Units/Day)	# Teams	Duration (Weeks)	Weekly Cost Per Team	Total
0100	Work Plans	1.00	LS	N/A	N/A	N/A	80,000	$80,000
0110	Explosive Safety Submission	1.00	LS	N/A	N/A	N/A	60,000	$60,000
0200	Mobilization	1.00	LS	N/A	N/A	N/A	36,750	$36,750
0210	Site-Set-up	1.00	LS	N/A	N/A	N/A	18,098	$18,098
0300	Site Management	37.34	WEEKS	1.00	1	37.34	23,758	$887,124
0310	Survey/Postioning	837.00	AC	12.00	1	13.95	11,810	$164,750
0320	Brush Clearing	837.00	AC	1.50	6	18.60	26,688	$2,978,381
0400	Surface MEC Removal	837.00	AC	3.00	5	11.16	29,561	$1,649,504
0410	Sub-Surface MEC Removal (M&D)	0.00	AC	1.40	1	0.00	34,844	$0
0420	Geophysical Mapping	0.00	AC	2.00	5	0.00	15,279	$0
0430	Geophysical Data Analysis	0.00	AC	3.00	3	0.00	5,875	$0
0440	Anomaly Re-Acquisition	0.00	AC	2.00	5	0.00	11,177	$0
0450	Sub-Surface MEC Removal (DGM Picks)	0.00	AC	2.00	1	0.00	34,844	$0
0500	MEC Disposal	837.00	AC	10.00	5	3.35	22,002	$368,313
0510	Scrap Disposal	837.00	AC	30.00	5	1.12	22,429	$125,154
0600	Site Restoration	837.00	AC	30.00	1	5.58	7,227	$40,327
0610	Demobilization	1.00	LS	N/A	N/A	N/A	35,750	$35,750
0700	Final Report	1.00	LS	N/A	N/A	N/A	50,000	$50,000
0800	Land Use Controls	1.00	LS	N/A	N/A	N/A	86,000	$86,000
	Sub-Total							$6,580,150
	Contingency	15%						$987,022
	Sub-Total							$7,567,172
	Infrastructure Improvements	2%						$151,343
	Project Management	5%						$378,359
	Remedial Design (USACE)	8%						$605,374
	Construction Management (USACE)	6%						$454,030
	Total Capital Cost							**$9,156,278**

ANNUAL O & M COST:

	Description		QTY	Unit	Unit Cost	Total
0900	Land Use Controls - Annual Cost		1	LS	9,500	$9,500
0910	Construction Support		4	WK	9,021	$36,084
	Sub-Total					$45,584
	Contingency	15%				$6,838
	Total Annual O & M Cost					$52,422

PERIODIC COST:

	Description	Year	QTY	Unit	Unit Cost	Total
1000	Five Year Review - First Review	5	1	EA	37,500	$37,500
1010	Five Year Review - Years 10,15,20,25 & 30	10 - 30	1	EA	22,500	$22,500

PRESENT VALUE ANALYSIS:

	Cost Type	Year	Total Cost	Total Cost Per Year	Discount Factor (%)	Present Value
	Capitol Cost	0	$9,156,278	$9,156,278	1	$9,156,278
0900	Annual O & M Cost	1 - 30	$1,572,648	$52,422	19.350	$1,014,358
0910	Periodic Cost	5	$37,500	$37,500	0.854	$32,025
0920	Periodic Cost	10	$22,500	$22,500	0.737	$16,583
0920	Periodic Cost	15	$22,500	$22,500	0.633	$14,243
0920	Periodic Cost	20	$22,500	$22,500	0.543	$12,218
0920	Periodic Cost	25	$22,500	$22,500	0.467	$10,508
0920	Periodic Cost	30	$22,500	$22,500	0.400	$9,000
			$10,878,926			$10,265,211
	Total Present Value of Alternative					**$10,265,211**

AC = acres, EA = each, LS = lump sum, N/A = not applicable, WK = week

AOC No: 3
Alternative No: 3
Surface Removal of MEC with Land Use Controls

CAPITAL COST:

Bid Item No.	Description	QTY	Unit	Team Production (Units/Day)	# Teams	Duration (Weeks)	Weekly Cost Per Team	Total
0100	Work Plans	1.00	LS	N/A	N/A	N/A	80,000	$80,000
0110	Explosive Safety Submission	1.00	LS	N/A	N/A	N/A	60,000	$60,000
0200	Mobilization	1.00	LS	N/A	N/A	N/A	36,750	$36,750
0210	Site-Set-up	1.00	LS	N/A	N/A	N/A	18,098	$18,098
0300	Site Management	11.71	WEEKS	1.00	1	11.71	23,758	$278,127
0310	Survey/Postioning	156.00	AC	12.00	1	2.60	11,810	$30,706
0320	Brush Clearing	156.00	AC	1.50	4	5.20	26,688	$555,110
0400	Surface MEC Removal	156.00	AC	3.00	3	3.47	29,561	$307,434
0410	Sub-Surface MEC Removal (M&D)	0.00	AC	1.40	2	0.00	34,844	$0
0420	Geophysical Mapping	0.00	AC	2.00	2	0.00	15,279	$0
0430	Geophysical Data Analysis	0.00	AC	3.00	2	0.00	5,875	$0
0440	Anomaly Re-Acquisition	0.00	AC	2.00	2	0.00	11,177	$0
0450	Sub-Surface MEC Removal (DGM Picks)	0.00	AC	2.00	2	0.00	34,844	$0
0500	MEC Disposal	156.00	AC	10.00	3	1.04	22,002	$68,646
0510	Scrap Disposal	156.00	AC	30.00	3	0.35	22,429	$23,326
0600	Site Restoration	156.00	AC	30.00	1	1.04	7,227	$7,516
0610	Demobilization	1.00	LS	N/A	N/A	N/A	35,750	$35,750
0700	Final Report	1.00	LS	N/A	N/A	N/A	50,000	$50,000
0800	Land Use Controls	1.00	LS	N/A	N/A	N/A	86,000	$86,000
	Sub-Total							$1,637,464
	Contingency	15%						$245,620
	Sub-Total							$1,883,084
	Infrastructure Improvements	2%						$37,662
	Project Management	5%						$94,154
	Remedial Design (USACE)	8%						$150,647
	Construction Management (USACE)	6%						$112,985
	Total Capital Cost							**$2,278,532**

ANNUAL O & M COST:

	Description		QTY	Unit	Unit Cost	Total
0900	Land Use Controls - Annual Cost		1	LS	9,500	$9,500
0910	Construction Support		4	WK	9,021	$36,084
	Sub-Total					$45,584
	Contingency	15%				$6,838
	Total Annual O & M Cost					$52,422

PERIODIC COST:

	Description	Year	QTY	Unit	Unit Cost	Total
1000	Five Year Review - First Review	5	1	EA	37,500	$37,500
1010	Five Year Review - Years 10,15,20,25 & 30	10 - 30	1	EA	22,500	$22,500

PRESENT VALUE ANALYSIS:

	Cost Type	Year	Total Cost	Total Cost Per Year	Discount Factor (%)	Present Value
	Capitol Cost	0	$2,278,532	$2,278,532	1	$2,278,532
0900	Annual O & M Cost	1 - 30	$1,572,648	$52,422	19.350	$1,014,358
0910	Periodic Cost	5	$37,500	$37,500	0.854	$32,025
0920	Periodic Cost	10	$22,500	$22,500	0.737	$16,583
0920	Periodic Cost	15	$22,500	$22,500	0.633	$14,243
0920	Periodic Cost	20	$22,500	$22,500	0.543	$12,218
0920	Periodic Cost	25	$22,500	$22,500	0.467	$10,508
0920	Periodic Cost	30	$22,500	$22,500	0.400	$9,000
			$4,001,180			$3,387,464
	Total Present Value of Alternative					**$3,387,464**

AC = acres, EA = each, LS = lump sum, N/A = not applicable, WK = week

AOC No: 4
Alternative No: 3
Surface Removal of MEC with Land Use Controls

CAPITAL COST:

Bid Item No.	Description	QTY	Unit	Team Production (Units/Day)	# Teams	Duration (Weeks)	Weekly Cost Per Team	Total
0100	Work Plans	1.00	LS	N/A	N/A	N/A	80,000	$80,000
0110	Explosive Safety Submission	1.00	LS	N/A	N/A	N/A	60,000	$60,000
0200	Mobilization	1.00	LS	N/A	N/A	N/A	36,750	$36,750
0210	Site-Set-up	1.00	LS	N/A	N/A	N/A	18,098	$18,098
0300	Site Management	30.56	WEEKS	1.00	1	30.56	23,758	$725,939
0310	Survey/Postioning	514.00	AC	12.00	1	8.57	11,810	$101,172
0320	Brush Clearing	514.00	AC	1.50	5	13.71	26,688	$1,829,018
0400	Surface MEC Removal	514.00	AC	3.00	3	11.42	29,561	$1,012,957
0410	Sub-Surface MEC Removal (M&D)	0.00	AC	1.40	1	0.00	34,844	$0
0420	Geophysical Mapping	0.00	AC	2.00	4	0.00	15,279	$0
0430	Geophysical Data Analysis	0.00	AC	3.00	3	0.00	5,875	$0
0440	Anomaly Re-Acquisition	0.00	AC	2.00	4	0.00	11,177	$0
0450	Sub-Surface MEC Removal (DGM Picks)	0.00	AC	2.00	1	0.00	34,844	$0
0500	MEC Disposal	514.00	AC	10.00	4	2.57	22,002	$226,181
0510	Scrap Disposal	514.00	AC	30.00	4	0.86	22,429	$76,857
0600	Site Restoration	514.00	AC	30.00	1	3.43	7,227	$24,765
0610	Demobilization	1.00	LS	N/A	N/A	N/A	35,750	$35,750
0700	Final Report	1.00	LS	N/A	N/A	N/A	50,000	$50,000
0800	Land Use Controls	1.00	LS	N/A	N/A	N/A	86,000	$86,000
	Sub-Total							$4,363,486
	Contingency	15%						$654,523
	Sub-Total							$5,018,008
	Infrastructure Improvements	2%						$100,360
	Project Management	5%						$250,900
	Remedial Design (USACE)	8%						$401,441
	Construction Management (USACE)	6%						$301,081
	Total Capital Cost							**$6,071,790**

ANNUAL O & M COST:

	Description		QTY	Unit	Unit Cost	Total
0900	Land Use Controls - Annual Cost		1	LS	9,500	$9,500
0910	Construction Support		4	WK	9,021	$36,084
	Sub-Total					$45,584
	Contingency	15%				$6,838
	Total Annual O & M Cost					$52,422

PERIODIC COST:

	Description	Year	QTY	Unit	Unit Cost	Total
1000	Five Year Review - First Review	5	1	EA	37,500	$37,500
1010	Five Year Review - Years 10,15,20,25 & 30	10 - 30	1	EA	22,500	$22,500

PRESENT VALUE ANALYSIS:

	Cost Type	Year	Total Cost	Total Cost Per Year	Discount Factor (%)	Present Value
	Capitol Cost	0	$6,071,790	$6,071,790	1	$6,071,790
0900	Annual O & M Cost	1 - 30	$1,572,648	$52,422	19.350	$1,014,358
0910	Periodic Cost	5	$37,500	$37,500	0.854	$32,025
0920	Periodic Cost	10	$22,500	$22,500	0.737	$16,583
0920	Periodic Cost	15	$22,500	$22,500	0.633	$14,243
0920	Periodic Cost	20	$22,500	$22,500	0.543	$12,218
0920	Periodic Cost	25	$22,500	$22,500	0.467	$10,508
0920	Periodic Cost	30	$22,500	$22,500	0.400	$9,000
			$7,794,438			$7,180,723
	Total Present Value of Alternative					**$7,180,723**

AC = acres, EA = each, LS = lump sum, N/A = not applicable, WK = week

AOC No: 5
Alternative No: 3
Surface Removal of MEC with Land Use Controls

CAPITAL COST:

Bid Item No.	Description	QTY	Unit	Team Production (Units/Day)	# Teams	Duration (Weeks)	Weekly Cost Per Team	Total
0100	Work Plans	1.00	LS	N/A	N/A	N/A	80,000	$80,000
0110	Explosive Safety Submission	1.00	LS	N/A	N/A	N/A	60,000	$60,000
0200	Mobilization	1.00	LS	N/A	N/A	N/A	36,750	$36,750
0210	Site-Set-up	1.00	LS	N/A	N/A	N/A	18,098	$18,098
0300	Site Management	23.07	WEEKS	1.00	1	23.07	23,758	$548,071
0310	Survey/Postioning	499.00	AC	12.00	1	8.32	11,810	$98,220
0320	Brush Clearing	499.00	AC	1.50	6	11.09	26,688	$1,775,642
0400	Surface MEC Removal	499.00	AC	3.00	5	6.65	29,561	$983,396
0410	Sub-Surface MEC Removal (M&D)	0.00	AC	1.40	1	0.00	34,844	$0
0420	Geophysical Mapping	0.00	AC	2.00	5	0.00	15,279	$0
0430	Geophysical Data Analysis	0.00	AC	3.00	3	0.00	5,875	$0
0440	Anomaly Re-Acquisition	0.00	AC	2.00	5	0.00	11,177	$0
0450	Sub-Surface MEC Removal (DGM Picks)	0.00	AC	2.00	1	0.00	34,844	$0
0500	MEC Disposal	499.00	AC	10.00	5	2.00	22,002	$219,580
0510	Scrap Disposal	499.00	AC	30.00	5	0.67	22,429	$74,614
0600	Site Restoration	499.00	AC	30.00	1	3.33	7,227	$24,042
0610	Demobilization	1.00	LS	N/A	N/A	N/A	35,750	$35,750
0700	Final Report	1.00	LS	N/A	N/A	N/A	50,000	$50,000
0800	Land Use Controls	1.00	LS	N/A	N/A	N/A	86,000	$86,000
	Sub-Total							$4,090,162
	Contingency	15%						$1,022,540
	Sub-Total							$5,112,702
	Infrastructure Improvements	2%						$102,254
	Project Management	5%						$255,635
	Remedial Design (USACE)	8%						$409,016
	Construction Management (USACE)	6%						$306,762
	Total Capital Cost							**$6,186,369**

ANNUAL O & M COST:

	Description		QTY	Unit	Unit Cost	Total
0900	Land Use Controls - Annual Cost		1	LS	9,500	$9,500
0910	Construction Support		4	WK	9,021	$36,084
	Sub-Total					$45,584
	Contingency	15%				$6,838
	Total Annual O & M Cost					$52,422

PERIODIC COST:

	Description	Year	QTY	Unit	Unit Cost	Total
1000	Five Year Review - First Review	5	1	EA	37,500	$37,500
1010	Five Year Review - Years 10,15,20,25 & 30	10 - 30	1	EA	22,500	$22,500

PRESENT VALUE ANALYSIS:

	Cost Type	Year	Total Cost	Total Cost Per Year	Discount Factor (%)	Present Value
	Capitol Cost	0	$6,186,369	$6,186,369	1	$6,186,369
0900	Annual O & M Cost	1 - 30	$1,572,648	$52,422	19.350	$1,014,358
0910	Periodic Cost	5	$37,500	$37,500	0.854	$32,025
0920	Periodic Cost	10	$22,500	$22,500	0.737	$16,583
0920	Periodic Cost	15	$22,500	$22,500	0.633	$14,243
0920	Periodic Cost	20	$22,500	$22,500	0.543	$12,218
0920	Periodic Cost	25	$22,500	$22,500	0.467	$10,508
0920	Periodic Cost	30	$22,500	$22,500	0.400	$9,000
			$7,909,017			$7,295,302
	Total Present Value of Alternative					**$7,295,302**

AC = acres, EA = each, LS = lump sum, N/A = not applicable, WK = week

COST ESTIMATES FOR ALTERNATIVE 4 –

REMOVAL OF UXO TO ONE FOOT WITH LAND USE CONTROLS

AOC No: 1
Alternative No: 4
Removal of MEC to One Foot with Land Use Controls

CAPITAL COST:

Bid Item No.	Description	QTY	Unit	Team Production (Units/Day)	# Teams	Duration (Weeks)	Weekly Cost Per Team	Total
0100	Work Plans	1.00	LS	N/A	N/A	N/A	80,000	$80,000
0110	Explosive Safety Submission	1.00	LS	N/A	N/A	N/A	60,000	$60,000
0200	Mobilization	1.00	LS	N/A	N/A	N/A	36,750	$36,750
0210	Site-Set-up	1.00	LS	N/A	N/A	N/A	18,098	$18,098
0300	Site Management	25.57	WEEKS	1.00	1	25.57	23,758	$607,475
0310	Survey/Postioning	166.00	AC	12.00	1	2.77	11,810	$32,674
0320	Brush Clearing	166.00	AC	1.50	4	5.53	26,688	$590,694
0400	Surface MEC Removal	166.00	AC	2.00	3	5.53	29,561	$490,713
0410	Sub-Surface MEC Removal (M&D)	83.00	AC	1.40	3	3.95	34,844	$413,150
0420	Geophysical Mapping	83.00	AC	2.00	2	4.15	15,279	$126,816
0430	Geophysical Data Analysis	83.00	AC	3.00	2	3.69	5,875	$32,508
0440	Anomaly Re-Acquisition	83.00	AC	2.00	2	4.15	11,177	$92,769
0450	Sub-Surface MEC Removal (DGM Picks)	83.00	AC	2.00	3	2.77	34,844	$289,205
0500	MEC Disposal	166.00	AC	10.00	3	1.11	22,002	$73,047
0510	Scrap Disposal	166.00	AC	30.00	3	0.37	22,429	$24,821
0600	Site Restoration	166.00	AC	25.00	1	1.33	7,227	$9,597
0610	Demobilization	1.00	LS	N/A	N/A	N/A	35,750	$35,750
0700	Final Report	1.00	LS	N/A	N/A	N/A	50,000	$50,000
0800	Land Use Controls	1.00	LS	N/A	N/A	N/A	86,000	$86,000
	Sub-Total							$3,150,068
	Contingency	15%						$472,510
	Sub-Total							$3,622,578
	Infrastructure Improvements	2%						$72,452
	Project Management	5%						$181,129
	Remedial Design (USACE)	8%						$289,806
	Construction Management (USACE)	6%						$217,355
	Total Capital Cost							**$4,383,320**

ANNUAL O & M COST:

	Description		QTY	Unit	Unit Cost	Total
0900	Land Use Controls - Annual Cost		1	LS	9,500	$9,500
0910	Construction Support		4	WK	9,021	$36,084
	Sub-Total					$45,584
	Contingency	15%				$6,838
	Total Annual O & M Cost					$52,422

PERIODIC COST:

	Description	Year	QTY	Unit	Unit Cost	Total
1000	Five Year Review - First Review	5	1	EA	37,500	$37,500
1010	Five Year Review - Years 10,15,20,25 & 30	10 - 30	1	EA	22,500	$22,500

PRESENT VALUE ANALYSIS:

	Cost Type	Year	Total Cost	Total Cost Per Year	Discount Factor (%)	Present Value
	Capitol Cost	0	$4,383,320	$4,383,320	1	$4,383,320
0900	Annual O & M Cost	1 - 30	$1,572,648	$52,422	19.350	$1,014,358
0910	Periodic Cost	5	$37,500	$37,500	0.854	$32,025
0920	Periodic Cost	10	$22,500	$22,500	0.737	$16,583
0920	Periodic Cost	15	$22,500	$22,500	0.633	$14,243
0920	Periodic Cost	20	$22,500	$22,500	0.543	$12,218
0920	Periodic Cost	25	$22,500	$22,500	0.467	$10,508
0920	Periodic Cost	30	$22,500	$22,500	0.400	$9,000
			$6,105,968			$5,492,253
	Total Present Value of Alternative					**$5,492,253**

AC = acres, EA = each, LS = lump sum, N/A = not applicable, WK = week

AOC No: 2
Alternative No: 4
Removal of MEC to One Foot with Land Use Controls

CAPITAL COST:

Bid Item No.	Description	QTY	Unit	Team Production (Units/Day)	# Teams	Duration (Weeks)	Weekly Cost Per Team	Total
0100	Work Plans	1.00	LS	N/A	N/A	N/A	80,000	$80,000
0110	Explosive Safety Submission	1.00	LS	N/A	N/A	N/A	60,000	$60,000
0200	Mobilization	1.00	LS	N/A	N/A	N/A	36,750	$36,750
0210	Site-Set-up	1.00	LS	N/A	N/A	N/A	18,098	$18,098
0300	Site Management	69.80	WEEKS	1.00	1	69.80	23,758	$1,658,383
0310	Survey/Postioning	837.00	AC	12.00	1	13.95	11,810	$164,750
0320	Brush Clearing	837.00	AC	1.50	6	18.60	26,688	$2,978,381
0400	Surface MEC Removal	837.00	AC	2.00	5	16.74	29,561	$2,474,256
0410	Sub-Surface MEC Removal (M&D)	418.50	AC	1.40	5	11.96	34,844	$2,083,173
0420	Geophysical Mapping	418.50	AC	2.00	5	8.37	15,279	$639,426
0430	Geophysical Data Analysis	418.50	AC	3.00	3	9.30	5,875	$163,913
0440	Anomaly Re-Acquisition	418.50	AC	2.00	5	8.37	11,177	$467,757
0450	Sub-Surface MEC Removal (DGM Picks)	418.50	AC	2.00	5	8.37	34,844	$1,458,221
0500	MEC Disposal	837.00	AC	10.00	5	3.35	22,002	$368,313
0510	Scrap Disposal	837.00	AC	30.00	5	1.12	22,429	$125,154
0600	Site Restoration	837.00	AC	25.00	1	6.70	7,227	$48,392
0610	Demobilization	1.00	LS	N/A	N/A	N/A	35,750	$35,750
0700	Final Report	1.00	LS	N/A	N/A	N/A	50,000	$50,000
0800	Land Use Controls	1.00	LS	N/A	N/A	N/A	86,000	$86,000
	Sub-Total							$12,996,717
	Contingency	15%						$1,949,508
	Sub-Total							$14,946,225
	Infrastructure Improvements	2%						$298,924
	Project Management	5%						$747,311
	Remedial Design (USACE)	8%						$1,195,698
	Construction Management (USACE)	6%						$896,773
	Total Capital Cost							**$18,084,932**

ANNUAL O & M COST:

	Description		QTY	Unit	Unit Cost	Total
0900	Land Use Controls - Annual Cost		1	LS	9,500	$9,500
0910	Construction Support		4	WK	9,021	$36,084
	Sub-Total					$45,584
	Contingency	15%				$6,838
	Total Annual O & M Cost					$52,422

PERIODIC COST:

	Description	Year	QTY	Unit	Unit Cost	Total
1000	Five Year Review - First Review	5	1	EA	37,500	$37,500
1010	Five Year Review - Years 10,15,20,25 & 30	10 - 30	1	EA	22,500	$22,500

PRESENT VALUE ANALYSIS:

	Cost Type	Year	Total Cost	Total Cost Per Year	Discount Factor (%)	Present Value
	Capitol Cost	0	18,084,932	$18,084,932	1	$18,084,932
0900	Annual O & M Cost	1 - 30	$1,572,648	52,422	19.350	$1,014,358
0910	Periodic Cost	5	$37,500	37,500	0.854	$32,025
0920	Periodic Cost	10	$22,500	22,500	0.737	$16,583
0920	Periodic Cost	15	$22,500	22,500	0.633	$14,243
0920	Periodic Cost	20	$22,500	22,500	0.543	$12,218
0920	Periodic Cost	25	$22,500	22,500	0.467	$10,508
0920	Periodic Cost	30	$22,500	22,500	0.400	$9,000
			$19,807,580			$19,193,865
	Total Present Value of Alternative					**$19,193,865**

AC = acres, EA = each, LS = lump sum, N/A = not applicable, WK = week

AOC No: 3
Alternative No: 4
Removal of MEC to One Foot with Land Use Controls

CAPITAL COST:

Bid Item No.	Description	QTY	Unit	Team Production (Units/Day)	# Teams	Duration (Weeks)	Weekly Cost Per Team	Total
0100	Work Plans	1.00	LS	N/A	N/A	N/A	80,000	$80,000
0110	Explosive Safety Submission	1.00	LS	N/A	N/A	N/A	60,000	$60,000
0200	Mobilization	1.00	LS	N/A	N/A	N/A	36,750	$36,750
0210	Site-Set-up	1.00	LS	N/A	N/A	N/A	18,098	$18,098
0300	Site Management	24.03	WEEKS	1.00	1	24.03	23,758	$570,880
0310	Survey/Postioning	156.00	AC	12.00	1	2.60	11,810	$30,706
0320	Brush Clearing	156.00	AC	1.50	4	5.20	26,688	$555,110
0400	Surface MEC Removal	156.00	AC	2.00	3	5.20	29,561	$461,152
0410	Sub-Surface MEC Removal (M&D)	78.00	AC	1.40	3	3.71	34,844	$388,262
0420	Geophysical Mapping	78.00	AC	2.00	2	3.90	15,279	$119,176
0430	Geophysical Data Analysis	78.00	AC	3.00	2	3.47	5,875	$30,550
0440	Anomaly Re-Acquisition	78.00	AC	2.00	2	3.90	11,177	$87,181
0450	Sub-Surface MEC Removal (DGM Picks)	78.00	AC	2.00	3	2.60	34,844	$271,783
0500	MEC Disposal	156.00	AC	10.00	3	1.04	22,002	$68,646
0510	Scrap Disposal	156.00	AC	30.00	3	0.35	22,429	$23,326
0600	Site Restoration	156.00	AC	25.00	1	1.25	7,227	$9,019
0610	Demobilization	1.00	LS	N/A	N/A	N/A	35,750	$35,750
0700	Final Report	1.00	LS	N/A	N/A	N/A	50,000	$50,000
0800	Land Use Controls	1.00	LS	N/A	N/A	N/A	86,000	$86,000
	Sub-Total							$2,982,389
	Contingency	15%						$447,358
	Sub-Total							$3,429,748
	Infrastructure Improvements	2%						$68,595
	Project Management	5%						$171,487
	Remedial Design (USACE)	8%						$274,380
	Construction Management (USACE)	6%						$205,785
	Total Capital Cost							**$4,149,995**

ANNUAL O & M COST:

	Description		QTY	Unit	Unit Cost	Total
0900	Land Use Controls - Annual Cost		1	LS	9,500	$9,500
0910	Construction Support		4	WK	9,021	$36,084
	Sub-Total					$45,584
	Contingency	15%				$6,838
	Total Annual O & M Cost					$52,422

PERIODIC COST:

	Description	Year	QTY	Unit	Unit Cost	Total
1000	Five Year Review - First Review	5	1	EA	37,500	$37,500
1010	Five Year Review - Years 10,15,20,25 & 30	10 - 30	1	EA	22,500	$22,500

PRESENT VALUE ANALYSIS:

	Cost Type	Year	Total Cost	Total Cost Per Year	Discount Factor (%)	Present Value
	Capitol Cost	0	$4,149,995	$4,149,995	1	$4,149,995
0900	Annual O & M Cost	1 - 30	$1,572,648	52,422	19.350	$1,014,358
0910	Periodic Cost	5	$37,500	37,500	0.854	$32,025
0920	Periodic Cost	10	$22,500	22,500	0.737	$16,583
0920	Periodic Cost	15	$22,500	22,500	0.633	$14,243
0920	Periodic Cost	20	$22,500	22,500	0.543	$12,218
0920	Periodic Cost	25	$22,500	22,500	0.467	$10,508
0920	Periodic Cost	30	$22,500	22,500	0.400	$9,000
			$5,872,643			$5,258,928
	Total Present Value of Alternative					**$5,258,928**

AC = acres, EA = each, LS = lump sum, N/A = not applicable, WK = week

AOC No: 4
Alternative No: 4
Removal of MEC to One Foot with Land Use Controls

CAPITAL COST:

Bid Item No.	Description	QTY	Unit	Team Production (Units/Day)	# Teams	Duration (Weeks)	Weekly Cost Per Team	Total
0100	Work Plans	1.00	LS	N/A	N/A	N/A	80,000	$80,000
0110	Explosive Safety Submission	1.00	LS	N/A	N/A	N/A	60,000	$60,000
0200	Mobilization	1.00	LS	N/A	N/A	N/A	36,750	$36,750
0210	Site-Set-up	1.00	LS	N/A	N/A	N/A	18,098	$18,098
0300	Site Management	45.44	WEEKS	1.00	1	45.44	23,758	$1,079,468
0310	Survey/Postioning	514.00	AC	12.00	1	8.57	11,810	$101,172
0320	Brush Clearing	514.00	AC	1.50	5	13.71	26,688	$1,829,018
0400	Surface MEC Removal	514.00	AC	2.00	5	10.28	29,561	$1,519,435
0410	Sub-Surface MEC Removal (M&D)	257.00	AC	1.40	5	7.34	34,844	$1,279,273
0420	Geophysical Mapping	257.00	AC	2.00	4	6.43	15,279	$392,670
0430	Geophysical Data Analysis	257.00	AC	3.00	3	5.71	5,875	$100,658
0440	Anomaly Re-Acquisition	257.00	AC	2.00	4	6.43	11,177	$287,249
0450	Sub-Surface MEC Removal (DGM Picks)	257.00	AC	2.00	5	5.14	34,844	$895,491
0500	MEC Disposal	514.00	AC	10.00	4	2.57	22,002	$226,181
0510	Scrap Disposal	514.00	AC	30.00	4	0.86	22,429	$76,857
0600	Site Restoration	514.00	AC	25.00	1	4.11	7,227	$29,717
0610	Demobilization	1.00	LS	N/A	N/A	N/A	35,750	$35,750
0700	Final Report	1.00	LS	N/A	N/A	N/A	50,000	$50,000
0800	Land Use Controls	1.00	LS	N/A	N/A	N/A	86,000	$86,000
	Sub-Total							$8,183,787
	Contingency	15%						$1,227,568
	Sub-Total							$9,411,355
	Infrastructure Improvements	2%						$188,227
	Project Management	5%						$470,568
	Remedial Design (USACE)	8%						$752,908
	Construction Management (USACE)	6%						$564,681
	Total Capital Cost							**$11,387,739**

ANNUAL O & M COST:

	Description		QTY	Unit	Unit Cost	Total
0900	Land Use Controls - Annual Cost		1	LS	9,500	$9,500
0910	Construction Support		4	WK	9,021	$36,084
	Sub-Total					$45,584
	Contingency	15%				$6,838
	Total Annual O & M Cost					$52,422

PERIODIC COST:

	Description	Year	QTY	Unit	Unit Cost	Total
1000	Five Year Review - First Review	5	1	EA	37,500	$37,500
1010	Five Year Review - Years 10,15,20,25 & 30	10 - 30	1	EA	22,500	$22,500

PRESENT VALUE ANALYSIS:

	Cost Type	Year	Total Cost	Total Cost Per Year	Discount Factor (%)	Present Value
	Capitol Cost	0	$11,387,739	$11,387,739	1	$11,387,739
0900	Annual O & M Cost	1 - 30	$1,572,648	52,422	19.350	$1,014,358
0910	Periodic Cost	5	$37,500	37,500	0.854	$32,025
0920	Periodic Cost	10	$22,500	22,500	0.737	$16,583
0920	Periodic Cost	15	$22,500	22,500	0.633	$14,243
0920	Periodic Cost	20	$22,500	22,500	0.543	$12,218
0920	Periodic Cost	25	$22,500	22,500	0.467	$10,508
0920	Periodic Cost	30	$22,500	22,500	0.400	$9,000
			$13,110,387			$12,496,672
	Total Present Value of Alternative					**$12,496,672**

AC = acres, EA = each, LS = lump sum, N/A = not applicable, WK = week

AOC No: 5
Alternative No: 4
Removal of MEC to One Foot with Land Use Controls

CAPITAL COST:

Bid Item No.	Description	QTY	Unit	Team Production (Units/Day)	# Teams	Duration (Weeks)	Weekly Cost Per Team	Total
0100	Work Plans	1.00	LS	N/A	N/A	N/A	80,000	$80,000
0110	Explosive Safety Submission	1.00	LS	N/A	N/A	N/A	60,000	$60,000
0200	Mobilization	1.00	LS	N/A	N/A	N/A	36,750	$36,750
0210	Site-Set-up	1.00	LS	N/A	N/A	N/A	18,098	$18,098
0300	Site Management	41.62	WEEKS	1.00	1	41.62	23,758	$988,690
0310	Survey/Postioning	499.00	AC	12.00	1	8.32	11,810	$98,220
0320	Brush Clearing	499.00	AC	1.50	6	11.09	26,688	$1,775,642
0400	Surface MEC Removal	499.00	AC	2.00	5	9.98	29,561	$1,475,094
0410	Sub-Surface MEC Removal (M&D)	249.50	AC	1.40	5	7.13	34,844	$1,241,940
0420	Geophysical Mapping	249.50	AC	2.00	5	4.99	15,279	$381,211
0430	Geophysical Data Analysis	249.50	AC	3.00	3	5.54	5,875	$97,721
0440	Anomaly Re-Acquisition	249.50	AC	2.00	5	4.99	11,177	$278,866
0450	Sub-Surface MEC Removal (DGM Picks)	249.50	AC	2.00	5	4.99	34,844	$869,358
0500	MEC Disposal	499.00	AC	10.00	5	2.00	22,002	$219,580
0510	Scrap Disposal	499.00	AC	30.00	5	0.67	22,429	$74,614
0600	Site Restoration	499.00	AC	25.00	1	3.99	7,227	$28,850
0610	Demobilization	1.00	LS	N/A	N/A	N/A	35,750	$35,750
0700	Final Report	1.00	LS	N/A	N/A	N/A	50,000	$50,000
0800	Land Use Controls	1.00	LS	N/A	N/A	N/A	86,000	$86,000
	Sub-Total							$7,896,382
	Contingency	15%						$1,184,457
	Sub-Total							$9,080,840
	Infrastructure Improvements	2%						$181,617
	Project Management	5%						$454,042
	Remedial Design (USACE)	8%						$726,467
	Construction Management (USACE)	6%						$544,850
	Total Capital Cost							**$10,987,816**

ANNUAL O & M COST:

	Description		QTY	Unit	Unit Cost	Total
0900	Land Use Controls - Annual Cost		1	LS	9,500	$9,500
0910	Construction Support		4	WK	9,021	$36,084
	Sub-Total					$45,584
	Contingency	15%				$6,838
	Total Annual O & M Cost					$52,422

PERIODIC COST:

	Description	Year	QTY	Unit	Unit Cost	Total
1000	Five Year Review - First Review	5	1	EA	37,500	$37,500
1010	Five Year Review - Years 10,15,20,25 & 30	10 - 30	1	EA	22,500	$22,500

PRESENT VALUE ANALYSIS:

	Cost Type	Year	Total Cost	Total Cost Per Year	Discount Factor (%)	Present Value
	Capitol Cost	0	$10,987,816	$10,987,816	1	$10,987,816
0900	Annual O & M Cost	1 - 30	$1,572,648	52,422	19.350	$1,014,358
0910	Periodic Cost	5	$37,500	37,500	0.854	$32,025
0920	Periodic Cost	10	$22,500	22,500	0.737	$16,583
0920	Periodic Cost	15	$22,500	22,500	0.633	$14,243
0920	Periodic Cost	20	$22,500	22,500	0.543	$12,218
0920	Periodic Cost	25	$22,500	22,500	0.467	$10,508
0920	Periodic Cost	30	$22,500	22,500	0.400	$9,000
			$12,710,464			$12,096,749
	Total Present Value of Alternative					**$12,096,749**

AC = acres, EA = each, LS = lump sum, N/A = not applicable, WK = week

COST ESTIMATES FOR ALTERNATIVE 5 –

REMOVAL OF UXO TO DETECTION DEPTH WITH LAND USE CONTROLS

AOC No: 1
Alternative No: 5
Removal of MEC to Detection Depth with Land Use Controls

CAPITAL COST:

Bid Item No.	Description	QTY	Unit	Team Production (Units/Day)	# Teams	Duration (Weeks)	Weekly Cost Per Team	Total
0100	Work Plans	1.00	LS	N/A	N/A	N/A	80,000	$80,000
0110	Explosive Safety Submission	1.00	LS	N/A	N/A	N/A	60,000	$60,000
0200	Mobilization	1.00	LS	N/A	N/A	N/A	36,750	$36,750
0210	Site-Set-up	1.00	LS	N/A	N/A	N/A	18,098	$18,098
0300	Site Management	28.62	WEEKS	1.00	1	28.62	23,758	$680,022
0310	Survey/Postioning	166.00	AC	12.00	1	2.77	11,810	$32,674
0320	Brush Clearing	166.00	AC	1.50	4	5.53	26,688	$590,694
0400	Surface MEC Removal	166.00	AC	2.00	3	5.53	29,561	$490,713
0410	Sub-Surface MEC Removal (M&D)	83.00	AC	1.00	3	5.53	34,844	$578,410
0420	Geophysical Mapping	83.00	AC	2.00	2	4.15	15,279	$126,816
0430	Geophysical Data Analysis	83.00	AC	3.00	2	3.69	5,875	$32,508
0440	Anomaly Re-Acquisition	83.00	AC	1.90	2	4.37	11,177	$97,652
0450	Sub-Surface MEC Removal (DGM Picks)	83.00	AC	1.50	3	3.69	34,844	$385,607
0500	MEC Disposal	166.00	AC	10.00	3	1.11	22,002	$73,047
0510	Scrap Disposal	166.00	AC	30.00	3	0.37	22,429	$24,821
0600	Site Restoration	166.00	AC	20.0	1	1.66	7,227	$11,997
0610	Demobilization	1.00	LS	N/A	N/A	N/A	35,750	$35,750
0700	Final Report	1.00	LS	N/A	N/A	N/A	50,000	$50,000
0800	Land Use Controls	1.00	LS	N/A	N/A	N/A	86,000	$86,000
	Sub-Total							$3,491,559
	Contingency	15%						$523,734
	Sub-Total							$4,015,293
	Infrastructure Improvements	2%						$80,306
	Project Management	5%						$200,765
	Remedial Design (USACE)	8%						$321,223
	Construction Management (USACE)	6%						$240,918
	Total Capital Cost							**$4,858,505**

ANNUAL O & M COST:

	Description		QTY	Unit	Unit Cost	Total
0900	Land Use Controls - Annual Cost		1	LS	9,500	$9,500
0910	Construction Support		1	WK	9,021	$9,021
	Sub-Total					$18,521
	Contingency	15%				$2,778
	Total Annual O & M Cost					$21,299

PERIODIC COST:

	Description	Year	QTY	Unit	Unit Cost	Total
1000	Five Year Review - First Review	5	1	EA	37,500	$37,500
1010	Five Year Review - Years 10,15,20,25 & 30	10 - 30	1	EA	22,500	$22,500

PRESENT VALUE ANALYSIS:

	Cost Type	Year	Total Cost	Total Cost Per Year	Discount Factor (%)	Present Value
	Capitol Cost	0	$4,858,505	$4,858,505	1	$4,858,505
0900	Annual O & M Cost	1 - 30	$638,975	$21,299	19.350	$412,139
0910	Periodic Cost	5	$37,500	$37,500	0.854	$32,025
0920	Periodic Cost	10	$22,500	$22,500	0.737	$16,583
0920	Periodic Cost	15	$22,500	$22,500	0.633	$14,243
0920	Periodic Cost	20	$22,500	$22,500	0.543	$12,218
0920	Periodic Cost	25	$22,500	$22,500	0.467	$10,508
0920	Periodic Cost	30	$22,500	$22,500	0.400	$9,000
			$5,647,479			$5,365,218
	Total Present Value of Alternative					**$5,365,218**

AC = acres, EA = each, LS = lump sum, N/A = not applicable, WK = week

AOC No: 2
Alternative No: 5
Removal of MEC to Detection Depth with Land Use Controls

CAPITAL COST:

Bid Item No.	Description	QTY	Unit	Team Production (Units/Day)	# Teams	Duration (Weeks)	Weekly Cost Per Team	Total
0100	Work Plans	1.00	LS	N/A	N/A	N/A	80,000	$80,000
0110	Explosive Safety Submission	1.00	LS	N/A	N/A	N/A	60,000	$60,000
0200	Mobilization	1.00	LS	N/A	N/A	N/A	36,750	$36,750
0210	Site-Set-up	1.00	LS	N/A	N/A	N/A	18,098	$18,098
0300	Site Management	79.49	WEEKS	1.00	1	79.49	23,758	$1,888,536
0310	Survey/Postioning	837.00	AC	12.00	1	13.95	11,810	$164,750
0320	Brush Clearing	837.00	AC	1.50	6	18.60	26,688	$2,978,381
0400	Surface MEC Removal	837.00	AC	2.00	5	16.74	29,561	$2,474,256
0410	Sub-Surface MEC Removal (M&D)	418.50	AC	1.00	5	16.74	34,844	$2,916,443
0420	Geophysical Mapping	418.50	AC	2.00	5	8.37	15,279	$639,426
0430	Geophysical Data Analysis	418.50	AC	3.00	3	9.30	5,875	$163,913
0440	Anomaly Re-Acquisition	418.50	AC	1.90	5	8.81	11,177	$492,376
0450	Sub-Surface MEC Removal (DGM Picks)	418.50	AC	1.50	5	11.16	34,844	$1,944,295
0500	MEC Disposal	837.00	AC	10.00	5	3.35	22,002	$368,313
0510	Scrap Disposal	837.00	AC	30.00	5	1.12	22,429	$125,154
0600	Site Restoration	837.00	AC	20.0	1	8.37	7,227	$60,490
0610	Demobilization	1.00	LS	N/A	N/A	N/A	35,750	$35,750
0700	Final Report	1.00	LS	N/A	N/A	N/A	50,000	$50,000
0800	Land Use Controls	1.00	LS	N/A	N/A	N/A	86,000	$86,000
	Sub-Total							$14,582,930
	Contingency	15%						$2,187,440
	Sub-Total							$16,770,370
	Infrastructure Improvements	2%						$335,407
	Project Management	5%						$838,518
	Remedial Design (USACE)	8%						$1,341,630
	Construction Management (USACE)	6%						$1,006,222
	Total Capital Cost							**$20,292,147**

ANNUAL O & M COST:

	Description		QTY	Unit	Unit Cost	Total
0900	Land Use Controls - Annual Cost		1	LS	9,500	$9,500
0910	Construction Support		1	WK	9,021	$9,021
	Sub-Total					$18,521
	Contingency	15%				$2,778
	Total Annual O & M Cost					$21,299

PERIODIC COST:

	Description	Year	QTY	Unit	Unit Cost	Total
1000	Five Year Review - First Review	5	1	EA	37,500	$37,500
1010	Five Year Review - Years 10,15,20,25 & 30	10 - 30	1	EA	22,500	$22,500

PRESENT VALUE ANALYSIS:

	Cost Type	Year	Total Cost	Total Cost Per Year	Discount Factor (%)	Present Value
	Capitol Cost	0	$20,292,147	$20,292,147	1	$20,292,147
0900	Annual O & M Cost	1 - 30	$638,975	$21,299	19.350	$412,139
0910	Periodic Cost	5	$37,500	$37,500	0.854	$32,025
0920	Periodic Cost	10	$22,500	$22,500	0.737	$16,583
0920	Periodic Cost	15	$22,500	$22,500	0.633	$14,243
0920	Periodic Cost	20	$22,500	$22,500	0.543	$12,218
0920	Periodic Cost	25	$22,500	$22,500	0.467	$10,508
0920	Periodic Cost	30	$22,500	$22,500	0.400	$9,000
			$21,081,122			$20,798,861
	Total Present Value of Alternative					**$20,798,861**

AC = acres, EA = each, LS = lump sum, N/A = not applicable, WK = week

AOC No: 3
Alternative No: 5
Removal of MEC to Detection Depth with Land Use Controls

CAPITAL COST:

Bid Item No.	Description	QTY	Unit	Team Production (Units/Day)	# Teams	Duration (Weeks)	Weekly Cost Per Team	Total
0100	Work Plans	1.00	LS	N/A	N/A	N/A	80,000	$80,000
0110	Explosive Safety Submission	1.00	LS	N/A	N/A	N/A	60,000	$60,000
0200	Mobilization	1.00	LS	N/A	N/A	N/A	36,750	$36,750
0210	Site-Set-up	1.00	LS	N/A	N/A	N/A	18,098	$18,098
0300	Site Management	26.90	WEEKS	1.00	1	26.90	23,758	$639,057
0310	Survey/Postioning	156.00	AC	12.00	1	2.60	11,810	$30,706
0320	Brush Clearing	156.00	AC	1.50	4	5.20	26,688	$555,110
0400	Surface MEC Removal	156.00	AC	2.00	3	5.20	29,561	$461,152
0410	Sub-Surface MEC Removal (M&D)	78.00	AC	1.00	3	5.20	34,844	$543,566
0420	Geophysical Mapping	78.00	AC	2.00	2	3.90	15,279	$119,176
0430	Geophysical Data Analysis	78.00	AC	3.00	2	3.47	5,875	$30,550
0440	Anomaly Re-Acquisition	78.00	AC	1.90	2	4.11	11,177	$91,769
0450	Sub-Surface MEC Removal (DGM Picks)	78.00	AC	1.50	3	3.47	34,844	$362,378
0500	MEC Disposal	156.00	AC	10.00	3	1.04	22,002	$68,646
0510	Scrap Disposal	156.00	AC	30.00	3	0.35	22,429	$23,326
0600	Site Restoration	156.00	AC	20.0	1	1.56	7,227	$11,274
0610	Demobilization	1.00	LS	N/A	N/A	N/A	35,750	$35,750
0700	Final Report	1.00	LS	N/A	N/A	N/A	50,000	$50,000
0800	Land Use Controls	1.00	LS	N/A	N/A	N/A	86,000	$86,000
	Sub-Total							$3,303,309
	Contingency	15%						$495,496
	Sub-Total							$3,798,805
	Infrastructure Improvements	2%						$75,976
	Project Management	5%						$189,940
	Remedial Design (USACE)	8%						$303,904
	Construction Management (USACE)	6%						$227,928
	Total Capital Cost							**$4,596,554**

ANNUAL O & M COST:

	Description		QTY	Unit	Unit Cost	Total
0900	Land Use Controls - Annual Cost		1	LS	9,500	$9,500
0910	Construction Support		1	WK	9,021	$9,021
	Sub-Total					$18,521
	Contingency	15%				$2,778
	Total Annual O & M Cost					$21,299

PERIODIC COST:

	Description	Year	QTY	Unit	Unit Cost	Total
1000	Five Year Review - First Review	5	1	EA	37,500	$37,500
1010	Five Year Review - Years 10,15,20,25 & 30	10 - 30	1	EA	22,500	$22,500

PRESENT VALUE ANALYSIS:

	Cost Type	Year	Total Cost	Total Cost Per Year	Discount Factor (%)	Present Value
	Capitol Cost	0	$4,596,554	$4,596,554	1	$4,596,554
0900	Annual O & M Cost	1 - 30	$638,975	$21,299	19.350	$412,139
0910	Periodic Cost	5	$37,500	$37,500	0.854	$32,025
0920	Periodic Cost	10	$22,500	$22,500	0.737	$16,583
0920	Periodic Cost	15	$22,500	$22,500	0.633	$14,243
0920	Periodic Cost	20	$22,500	$22,500	0.543	$12,218
0920	Periodic Cost	25	$22,500	$22,500	0.467	$10,508
0920	Periodic Cost	30	$22,500	$22,500	0.400	$9,000
			$5,385,528			$5,103,268
	Total Present Value of Alternative					$5,103,268

AC = acres, EA = each, LS = lump sum, N/A = not applicable, WK = week

AOC No: 4
Alternative No: 5
Removal of MEC to Detection Depth with Land Use Controls

CAPITAL COST:

Bid Item No.	Description	QTY	Unit	Team Production (Units/Day)	# Teams	Duration (Weeks)	Weekly Cost Per Team	Total
0100	Work Plans	1.00	LS	N/A	N/A	N/A	80,000	$80,000
0110	Explosive Safety Submission	1.00	LS	N/A	N/A	N/A	60,000	$60,000
0200	Mobilization	1.00	LS	N/A	N/A	N/A	36,750	$36,750
0210	Site-Set-up	1.00	LS	N/A	N/A	N/A	18,098	$18,098
0300	Site Management	51.45	WEEKS	1.00	1	51.45	23,758	$1,222,411
0310	Survey/Postioning	514.00	AC	12.00	1	8.57	11,810	$101,172
0320	Brush Clearing	514.00	AC	1.50	5	13.71	26,688	$1,829,018
0400	Surface MEC Removal	514.00	AC	2.00	5	10.28	29,561	$1,519,435
0410	Sub-Surface MEC Removal (M&D)	257.00	AC	1.00	5	10.28	34,844	$1,790,982
0420	Geophysical Mapping	257.00	AC	2.00	4	6.43	15,279	$392,670
0430	Geophysical Data Analysis	257.00	AC	3.00	3	5.71	5,875	$100,658
0440	Anomaly Re-Acquisition	257.00	AC	1.90	4	6.76	11,177	$302,367
0450	Sub-Surface MEC Removal (DGM Picks)	257.00	AC	1.50	5	6.85	34,844	$1,193,988
0500	MEC Disposal	514.00	AC	10.00	4	2.57	22,002	$226,181
0510	Scrap Disposal	514.00	AC	30.00	4	0.86	22,429	$76,857
0600	Site Restoration	514.00	AC	20.0	1	5.14	7,227	$37,147
0610	Demobilization	1.00	LS	N/A	N/A	N/A	35,750	$35,750
0700	Final Report	1.00	LS	N/A	N/A	N/A	50,000	$50,000
0800	Land Use Controls	1.00	LS	N/A	N/A	N/A	86,000	$86,000
	Sub-Total							$9,159,484
	Contingency	15%						$1,373,923
	Sub-Total							$10,533,406
	Infrastructure Improvements	2%						$210,668
	Project Management	5%						$526,670
	Remedial Design (USACE)	8%						$842,672
	Construction Management (USACE)	6%						$632,004
	Total Capital Cost							**$12,745,421**

ANNUAL O & M COST:

	Description		QTY	Unit	Unit Cost	Total
0900	Land Use Controls - Annual Cost		1	LS	9,500	$9,500
0910	Construction Support		1	WK	9,021	$9,021
	Sub-Total					$18,521
	Contingency	15%				$2,778
	Total Annual O & M Cost					$21,299

PERIODIC COST:

	Description	Year	QTY	Unit	Unit Cost	Total
1000	Five Year Review - First Review	5	1	EA	37,500	$37,500
1010	Five Year Review - Years 10,15,20,25 & 30	10 - 30	1	EA	22,500	$22,500

PRESENT VALUE ANALYSIS:

	Cost Type	Year	Total Cost	Total Cost Per Year	Discount Factor (%)	Present Value
	Capitol Cost	0	$12,745,421	$12,745,421	1	$12,745,421
0900	Annual O & M Cost	1 - 30	$638,975	$21,299	19.350	$412,139
0910	Periodic Cost	5	$37,500	$37,500	0.854	$32,025
0920	Periodic Cost	10	$22,500	$22,500	0.737	$16,583
0920	Periodic Cost	15	$22,500	$22,500	0.633	$14,243
0920	Periodic Cost	20	$22,500	$22,500	0.543	$12,218
0920	Periodic Cost	25	$22,500	$22,500	0.467	$10,508
0920	Periodic Cost	30	$22,500	$22,500	0.400	$9,000
			$13,534,396			$13,252,135
	Total Present Value of Alternative					**$13,252,135**

AC = acres, EA = each, LS = lump sum, N/A = not applicable, WK = week

AOC No: 5
Alternative No: 5
Removal of MEC to Detection Depth with Land Use Controls

CAPITAL COST:

Bid Item No.	Description	QTY	Unit	Team Production (Units/Day)	# Teams	Duration (Weeks)	Weekly Cost Per Team	Total
0100	Work Plans	1.00	LS	N/A	N/A	N/A	80,000	$80,000
0110	Explosive Safety Submission	1.00	LS	N/A	N/A	N/A	60,000	$60,000
0200	Mobilization	1.00	LS	N/A	N/A	N/A	36,750	$36,750
0210	Site-Set-up	1.00	LS	N/A	N/A	N/A	18,098	$18,098
0300	Site Management	47.39	WEEKS	1.00	1	47.39	23,758	$1,125,901
0310	Survey/Postioning	499.00	AC	12.00	1	8.32	11,810	$98,220
0320	Brush Clearing	499.00	AC	1.50	6	11.09	26,688	$1,775,642
0400	Surface MEC Removal	499.00	AC	2.00	5	9.98	29,561	$1,475,094
0410	Sub-Surface MEC Removal (M&D)	249.50	AC	1.00	5	9.98	34,844	$1,738,716
0420	Geophysical Mapping	249.50	AC	2.00	5	4.99	15,279	$381,211
0430	Geophysical Data Analysis	249.50	AC	3.00	3	5.54	5,875	$97,721
0440	Anomaly Re-Acquisition	249.50	AC	1.90	5	5.25	11,177	$293,543
0450	Sub-Surface MEC Removal (DGM Picks)	249.50	AC	1.50	5	6.65	34,844	$1,159,144
0500	MEC Disposal	499.00	AC	10.00	5	2.00	22,002	$219,580
0510	Scrap Disposal	499.00	AC	30.00	5	0.67	22,429	$74,614
0600	Site Restoration	499.00	AC	20.0	1	4.99	7,227	$36,063
0610	Demobilization	1.00	LS	N/A	N/A	N/A	35,750	$35,750
0700	Final Report	1.00	LS	N/A	N/A	N/A	50,000	$50,000
0800	Land Use Controls	1.00	LS	N/A	N/A	N/A	86,000	$86,000
	Sub-Total							$8,842,046
	Contingency	15%						$1,326,307
	Sub-Total							$10,168,353
	Infrastructure Improvements	2%						$203,367
	Project Management	5%						$508,418
	Remedial Design (USACE)	8%						$813,468
	Construction Management (USACE)	6%						$610,101
	Total Capital Cost							**$12,303,707**

ANNUAL O & M COST:

	Description		QTY	Unit	Unit Cost	Total
0900	Land Use Controls - Annual Cost		1	LS	9,500	$9,500
0910	Construction Support		1	WK	9,021	$9,021
	Sub-Total					$18,521
	Contingency	15%				$2,778
	Total Annual O & M Cost					$21,299

PERIODIC COST:

	Description	Year	QTY	Unit	Unit Cost	Total
1000	Five Year Review - First Review	5	1	EA	37,500	$37,500
1010	Five Year Review - Years 10,15,20,25 & 30	10 - 30	1	EA	22,500	$22,500

PRESENT VALUE ANALYSIS:

	Cost Type	Year	Total Cost	Total Cost Per Year	Discount Factor (%)	Present Value
	Capitol Cost	0	$12,303,707	$12,303,707	1	$12,303,707
0900	Annual O & M Cost	1 - 30	$638,975	$21,299	19.350	$412,139
0910	Periodic Cost	5	$37,500	$37,500	0.854	$32,025
0920	Periodic Cost	10	$22,500	$22,500	0.737	$16,583
0920	Periodic Cost	15	$22,500	$22,500	0.633	$14,243
0920	Periodic Cost	20	$22,500	$22,500	0.543	$12,218
0920	Periodic Cost	25	$22,500	$22,500	0.467	$10,508
0920	Periodic Cost	30	$22,500	$22,500	0.400	$9,000
			$13,092,681			$12,810,420
	Total Present Value of Alternative					**$12,810,420**

AC = acres, EA = each, LS = lump sum, N/A = not applicable, WK = week

COST BY AOC - ALTERNATIVE 5
Removal of MEC to Detection Depth with Land Use Controls

CAPITAL COST:

Bid Item No.	Description	AOC 1	AOC 2	AOC 3	AOC 4	AOC 5	TOTAL ALL AOCs
0100	Work Plans	$80,000	$80,000	$80,000	$80,000	$80,000	**$400,000**
0110	Explosive Safety Submission	$60,000	$60,000	$60,000	$60,000	$60,000	**$300,000**
0200	Mobilization	$36,750	$36,750	$36,750	$36,750	$36,750	**$183,750**
0210	Site-Set-up	$18,098	$18,098	$18,098	$18,098	$18,098	**$90,490**
0300	Site Management	$680,022	$1,888,536	$639,057	$1,222,411	$1,125,901	**$5,555,927**
0310	Survey/Postioning	$32,674	$164,750	$30,706	$101,172	$98,220	**$427,522**
0320	Brush Clearing	$590,694	$2,978,381	$555,110	$1,829,018	$1,775,642	**$7,728,845**
0400	Surface MEC Removal	$490,713	$2,474,256	$461,152	$1,519,435	$1,475,094	**$6,420,649**
0410	Sub-Surface MEC Removal (M&D)	$578,410	$2,916,443	$543,566	$1,790,982	$1,738,716	**$7,568,117**
0420	Geophysical Mapping	$126,816	$639,426	$119,176	$392,670	$381,211	**$1,659,299**
0430	Geophysical Data Analysis	$32,508	$163,913	$30,550	$100,658	$97,721	**$425,350**
0440	Anomaly Re-Acquisition	$97,652	$492,376	$91,769	$302,367	$293,543	**$1,277,708**
0450	Sub-Surface MEC Removal (DGM Picks)	$385,607	$1,944,295	$362,378	$1,193,988	$1,159,144	**$5,045,411**
0500	MEC Disposal	$73,047	$368,313	$68,646	$226,181	$219,580	**$955,767**
0510	Scrap Disposal	$24,821	$125,154	$23,326	$76,857	$74,614	**$324,772**
0600	Site Restoration	$11,997	$60,490	$11,274	$37,147	$36,063	**$156,970**
0610	Demobilization	$35,750	$35,750	$35,750	$35,750	$35,750	**$178,750**
0700	Final Report	$50,000	$50,000	$50,000	$50,000	$50,000	**$250,000**
0800	Land Use Controls	$86,000	$86,000	$86,000	$86,000	$86,000	**$430,000**
	Sub-Total	$3,491,559	$14,582,930	$3,303,309	$9,159,484	$8,842,046	**$39,379,327**
	Contingency	$523,734	$2,187,440	$495,496	$1,373,923	$1,326,307	**$5,906,899**
	Sub-Total	$4,015,293	$16,770,370	$3,798,805	$10,533,406	$10,168,353	**$45,286,226**
	Infrastructure Improvements	$80,306	$335,407	$75,976	$210,668	$203,367	**$905,725**
	Project Management	$200,765	$838,518	$189,940	$526,670	$508,418	**$2,264,311**
	Remedial Design (USACE)	$321,223	$1,341,630	$303,904	$842,672	$813,468	**$3,622,898**
	Construction Management (USACE)	$240,918	$1,006,222	$227,928	$632,004	$610,101	**$2,717,174**
	Total Capital Cost	**$4,858,505**	**$20,292,147**	**$4,596,554**	**$12,745,421**	**$12,303,707**	**$54,796,334**

ANNUAL O & M COST:

	Description	Total	Total	Total	Total	Total	**Total**
0900	Land Use Controls - Annual Cost	$9,500	$9,500	$9,500	$9,500	$9,500	**$47,500**
0910	Construction Support	$9,021	$9,021	$9,021	$9,021	$9,021	**$45,105**
	Sub-Total	$18,521	$18,521	$18,521	$18,521	$18,521	**$92,605**
	Contingency	$2,778	$2,778	$2,778	$2,778	$2,778	**$13,891**
	Total Annual O & M Cost	$21,299	$21,299	$21,299	$21,299	$21,299	**$106,496**

PERIODIC COST:

	Description	Total	Total	Total	Total	Total	**Total**
1000	Five Year Review - First Review	$37,500	$37,500	$37,500	$37,500	$37,500	**$187,500**
1010	Five Year Review - Years 10,15,20,25 & 30	$22,500	$22,500	$22,500	$22,500	$22,500	**$112,500**

PRESENT VALUE ANALYSIS:

	Cost Type	Present Value	Present Value	Present Value	Present Value	Present Value	**Present Value**
	Capitol Cost	$4,858,505	$20,292,147	$4,596,554	$12,745,421	$12,303,707	**$54,796,334**
0900	Annual O & M Cost	$412,139	$412,139	$412,139	$412,139	$412,139	**$2,060,693**
0910	Periodic Cost	$32,025	$32,025	$32,025	$32,025	$32,025	**$160,125**
0920	Periodic Cost	$16,583	$16,583	$16,583	$16,583	$16,583	**$82,913**
0920	Periodic Cost	$14,243	$14,243	$14,243	$14,243	$14,243	**$71,213**
0920	Periodic Cost	$12,218	$12,218	$12,218	$12,218	$12,218	**$61,088**
0920	Periodic Cost	$10,508	$10,508	$10,508	$10,508	$10,508	**$52,538**
0920	Periodic Cost	$9,000	$9,000	$9,000	$9,000	$9,000	**$45,000**
		$5,365,218	$20,798,861	$5,103,268	$13,252,135	$12,810,420	**$57,329,902**
	Total Present Value of Alternative	**$5,365,218**	**$20,798,861**	**$5,103,268**	**$13,252,135**	**$12,810,420**	**$57,329,902**

SUPPORTING COST INFORMATION

TOAR - FUDS ()
Feasibility Study Cost Estimate
Worksheet: 0100 - Work Plans

Worksheet Header: **Quantity:** 1.00 **Unit:** LS **Estimator:** DM **Revision:** **Rev. Date:** **Start Date:** **End Date:**

Work Codes

01.00 WSB 01A030 Alt. 3 SR Atomic-Vapor Hand Excavation

Formula Variables

Global Variables

Notes

Includes Draft, Final Draft, and Final

Line	Resource	Description	Quantity	Unit	Manhours	Labor	Travel	Equipment	Subcontract	Internal	External	T & D	Bnd/Insr	(Not Used)	(Not Used)	Total Cost
1.00	30000100	Health & Safety Plan	1.00	LS					30,000.00 30,000.00							30,000.00 30,000.00
2.00	30000101	Work Plan	1.00	LS					50,000.00 50,000.00							50,000.00 50,000.00
		Worksheet Header	1.00	LS					80,000.00							80,000.00
		Sheet Totals							80,000.00							80,000.00

TOAR - FUDS ()
Feasibility Study Cost Estimate
Worksheet: 0110 - Explosive Safety Submission

Worksheet Header: **Quantity:** 1.00 **Unit:** LS **Estimator:** DM **Revision:** **Rev. Date:** **Start Date:** **End Date:**

Work Codes

Formula Variables
Global Variables

Notes
Includes Draft, Final Draft, and Final

Line	Resource	Description	Quantity	Unit	Manhours	Labor	Travel	Equipment	Subcontract	Internal	External	T & D	Bnd/Insr	(Not Used)	(Not Used)	Total Cost
1.00	30000102	Explosive Safety Submittal	1.00	LS					60,000.00 60,000.00							60,000.00 60,000.00
		Worksheet Header	1.00	LS					60,000.00							60,000.00
		Sheet Totals							60,000.00							60,000.00

TOAR - FUDS ()
Feasibility Study Cost Estimate
Worksheet: 0200 - Mobilization

Worksheet Header: **Quantity:** 1.00 **Unit:** LS **Estimator:** DM **Revision:** **Rev. Date:** **Start Date:** **End Date:**

Work Codes

01.00 WSB 01A030 Alt. 3 SR Atomic-Vapor Hand Excavation

Formula Variables

Global Variables

Notes

Assumed 30 People on site at $1000 per serson

Line	Resource	Description	Quantity	Unit	Manhours	Labor	Travel	Equipment	Subcontract	Internal	External	T & D	Bnd/Insr	(Not Used)	(Not Used)	Total Cost
1.00	3000SBMZ	Subcontract: Mobilization	10.00	EA					5,500.00							5,500.00
		Miscellanous Equipment							550.00							550.00
2.00	51000100	Miscellaneous ODCs	5.00	DY							250.00					250.00
											50.00					50.00
3.00	51000102	Decon Equipment & Supplies	1.00	LS							1,000.00					1,000.00
											1,000.00					1,000.00
4.00	60000009	Mobilization Allowance per person	30.00	EA							30,000.00					30,000.00
											1,000.00					1,000.00
		Worksheet Header	1.00	LS					5,500.00		31,250.00					36,750.00
		Sheet Totals							5,500.00		31,250.00					36,750.00

TOAR - FUDS ()
Feasibility Study Cost Estimate
Worksheet: 0210 - Site-Set-up

Worksheet Header: **Quantity:** 1.00 **Unit:** LS **Estimator:** DM **Revision:** **Rev. Date:** **Start Date:** **End Date:**

Work Codes

01.00 WSB 01A030 Alt. 3 SR Atomic-Vapor Hand Excavation

Formula Variables

Global Variables

Notes

Set-up of 2 Office Trailers
5 - 10 hour days
Per Diem at 7 days per week

Line	Resource	Description	Quantity	Unit	Manhours	Labor	Travel	Equipment	Subcontract	Internal	External	T & D	Bnd/Insr	(Not Used)	(Not Used)	Total Cost
1.00	3000FTM2	Mob. Field Office - 10' x 44' - WillaimsScottsman	2.00	LS					671.00							671.00
									335.50							335.50
2.00	3000FTM4	Field Office Trailer: Block & Level - WilliamsScottsman	2.00	LS					198.00							198.00
									99.00							99.00
3.00	3000FTM6	Setup/Anchor Trailer: WilliamsScottsman	2.00	LS					352.00							352.00
									176.00							176.00
4.00	3000ELT1	Electrical Sub - Install 600 amp Temp Service - Budget	2.00	LS					5,000.00							5,000.00
									2,500.00							2,500.00
5.00	11000003	Heavy Equipment Operator	50.00	HR	50.00 1.00	3,384.50 67.69										3,384.50 67.69
6.00	11000005	Laborer (2)	100.00	HR	100.00 1.00	4,668.00 46.68										4,668.00 46.68
7.00	2500C416	Cat. - 420D Backhoe/Loader	5.00	DY				453.75 90.75								453.75 90.75
8.00	51000001	FOGM	50.00	GL							110.00 2.20					110.00 2.20
9.00	51000012	Stone	40.00	TN							528.00 13.20					528.00 13.20
10.00	25000020	Pick-up Truck 4 x 4 w/fogm (2)	10.00	DY				528.00 52.80								528.00 52.80
11.00	60000010	Per Diem	21.00	DY			2,205.00 105.00									2,205.00 105.00

TOAR - FUDS ()
Feasibility Study Cost Estimate
Worksheet: 0210 - Site-Set-up

Line	Resource	Description	Quantity	Unit	Manhours	Labor	Travel	Equipment	Subcontract	Internal	External	T & D	Bnd/Insr	(Not Used)	(Not Used)	Total Cost
		Worksheet Header	1.00	LS	150.00	8,052.50	2,205.00	981.75	6,221.00		638.00					18,098.25
		Sheet Totals			150.00	8,052.50	2,205.00	981.75	6,221.00		638.00					18,098.25

TOAR - FUDS ()
Feasibility Study Cost Estimate
Worksheet: 0300 - Site Management

Worksheet Header: **Quantity:** 1.00 **Unit:** WK **Estimator:** DM **Revision:** **Rev. Date:** **Start Date:** **End Date:**

Work Codes

Formula Variables

Global Variables

Notes

5 - 10 hour days
Per Diem at 7 days per week

Line	Resource	Description	Quantity	Unit	Manhours	Labor	Travel	Equipment	Subcontract	Internal	External	T & D	Bnd/Insr	(Not Used)	(Not Used)	Total Cost
1.00	11000004	Field Office Administrator	50.00	HR	50.00 1.00	1,990.00 39.80										1,990.00 39.80
2.00	11000012	UXO SSHO	50.00	HR	50.00 1.00	3,410.00 68.20										3,410.00 68.20
3.00	11000025	Site Manager	50.00	HR	50.00 1.00	3,630.00 72.60										3,630.00 72.60
4.00	11000019	UXO QC Specialist	50.00	HR	50.00 1.00	3,520.00 70.40										3,520.00 70.40
5.00	11000024	UXO Technician V (SUXOS)	50.00	HR	50.00 1.00	4,284.50 85.69										4,284.50 85.69
6.00	25000003	Blasting Machine	5.00	DY				82.50 16.50								82.50 16.50
7.00	25000007	Computer	5.00	DY				57.50 11.50								57.50 11.50
8.00	25000008	Copier/Fax	5.00	DY				44.00 8.80								44.00 8.80
9.00	25000009	Generator w/fogm	5.00	DY				209.00 41.80								209.00 41.80
10.00	25000010	Internet Service	5.00	DY					27.50 5.50							27.50 5.50
11.00	25000011	Port -A- John (2)	5.00	DY				46.75 9.35								46.75 9.35
12.00	25000012	Printer	5.00	DY				57.50 11.50								57.50 11.50
13.00	25000013	Storm Detector	5.00	DY				412.50 82.50								412.50 82.50
14.00	25000020	Pick-up Truck 4 x 4 w/fogm (2)	10.00	DY				528.00 52.80								528.00 52.80

TOAR - FUDS ()
Feasibility Study Cost Estimate
Worksheet: 0300 - Site Management

Line	Resource	Description	Quantity	Unit	Manhours	Labor	Travel	Equipment	Subcontract	Internal	External	T & D	Bnd/Insr	(Not Used)	(Not Used)	Total Cost
15.00	25000022	SUV 4x4 w/fogm	5.00	DY				429.00 85.80								429.00 85.80
16.00	2500BKR3	Storage Box (CONEX) / Lockable	5.00	DY				82.50 16.50								82.50 16.50
17.00	2500FTM7	Field Office Trailer 10' x 44' W/OSHA Steps	5.00	DY				56.25 11.25								56.25 11.25
18.00	51000005	Consumable Supplies	5.00	DY							500.00 100.00					500.00 100.00
19.00	25000005	Cell Phone	5.00	DY				23.40 4.68								23.40 4.68
20.00	5100PHN1	Project Phone Service	5.00	DY							57.50 11.50					57.50 11.50
21.00	51000013	GPS - Hand Held	5.00	DY							302.50 60.50					302.50 60.50
22.00	51000103	Radio's	5.00	DY				137.50 27.50								137.50 27.50
23.00	51000105	Mechanics Tool Kit	5.00	DY							27.50 5.50					27.50 5.50
24.00	51000106	Explosive Magazine	5.00	DY							57.50 11.50					57.50 11.50
25.00	51000006	Demolition Tool Kit	5.00	LS							110.00 22.00					110.00 22.00
26.00	60000010	Per Diem	35.00	DY			3,675.00 105.00									3,675.00 105.00
		Worksheet Header	1.00	WK	250.00	16,834.50	3,675.00	2,166.40	27.50		1,055.00					23,758.40
		Sheet Totals			250.00	16,834.50	3,675.00	2,166.40	27.50		1,055.00					23,758.40

TOAR - FUDS ()
Feasibility Study Cost Estimate
Worksheet: 0310 - Survey/Postioning

Worksheet Header: **Quantity:** 1.00 **Unit:** WK **Estimator:** DM **Revision:** **Rev. Date:** **Start Date:** **End Date:**

Work Codes

01.00 WSB 01A030 Alt. 3 SR Atomic-Vapor Hand Excavation

Formula Variables

Global Variables

Notes

UXO Tech II Escort required for Survey crew
5 - 10 hour days
Per Diem at 7 days per week

Line	Resource	Description	Quantity	Unit	Manhours	Labor	Travel	Equipment	Subcontract	Internal	External	T & D	Bnd/Insr	(Not Used)	(Not Used)	Total Cost
1.00	11000013	Survey Technician	50.00	HR	50.00 1.00	1,905.00 38.10										1,905.00 38.10
2.00	11000014	Survey Party Chief	50.00	HR	50.00 1.00	2,355.00 47.10										2,355.00 47.10
3.00	11000015	Survey Manager	5.00	HR	5.00 1.00	329.00 65.80										329.00 65.80
4.00	11000021	UXO Technician II	50.00	HR	50.00 1.00	3,052.50 61.05										3,052.50 61.05
5.00	25000022	SUV 4x4 w/fogm	.50	DY				42.90 85.80								42.90 85.80
6.00	25000014	Surveyors Kit	5.00	DY				550.00 110.00								550.00 110.00
7.00	2500MISC1	Miscellaneous Small Tools/Eqip	5.00	DY				250.00 50.00								250.00 50.00
8.00	25000007	Computer	5.00	DY				57.50 11.50								57.50 11.50
9.00	51000005	Consumable Supplies	5.00	DY							500.00 100.00					500.00 100.00
10.00	30000203	Schoenstedt (4)	5.00	DY							57.50 11.50					57.50 11.50
11.00	51000001	FOGM	5.00	GL							11.00 2.20					11.00 2.20
12.00	60000010	Per Diem	7.00	DY			735.00 105.00									735.00 105.00
13.00	30000204	Radio's	5.00	DY							26.60 5.32					26.60 5.32
14.00	30000205	GPS - RTK	5.00	DY							1,188.00 237.60					1,188.00 237.60

TOAR - FUDS ()
Feasibility Study Cost Estimate
Worksheet: 0310 - Survey/Postioning

Line	Resource	Description	Quantity	Unit	Manhours	Labor	Travel	Equipment	Subcontract	Internal	External	T & D	Bnd/Insr	(Not Used)	(Not Used)	Total Cost
15.00	25000027	Total Station	5.00	DY				750.00 150.00								750.00 150.00
		Worksheet Header	1.00	WK	155.00	7,641.50	735.00	1,650.40			1,783.10					11,810.00
		Sheet Totals			155.00	7,641.50	735.00	1,650.40			1,783.10					11,810.00

TOAR - FUDS ()
Feasibility Study Cost Estimate
Worksheet: 0320 - Brush Clearing

Worksheet Header: **Quantity:** 1.00 **Unit:** WK **Estimator:** DM **Revision:** **Rev. Date:** **Start Date:** **End Date:**

Work Codes

01.00 WSB 01A030 Alt. 3 SR Atomic-Vapor Hand Excavation

Formula Variables

Global Variables

Notes

5 - 10 hour days
Per Diem at 7 days per week

Line	Resource	Description	Quantity	Unit	Manhours	Labor	Travel	Equipment	Subcontract	Internal	External	T & D	Bnd/Insr	(Not Used)	(Not Used)	Total Cost
1.00	11000003	Heavy Equipment Operator	50.00	HR	50.00 1.00	3,384.50 67.69										3,384.50 67.69
2.00	11000005	Laborer (4)	200.00	HR	200.00 1.00	9,336.00 46.68										9,336.00 46.68
3.00	11000009	Truck Driver (MED)	50.00	HR	50.00 1.00	1,973.50 39.47										1,973.50 39.47
4.00	11000022	UXO Technician III	50.00	HR	50.00 1.00	3,658.50 73.17										3,658.50 73.17
5.00	25000004	Brush cutter, Power	5.00	DY				82.50 16.50								82.50 16.50
6.00	25000006	Chain Saw (4)	20.00	DY				330.00 16.50								330.00 16.50
7.00	2500HE09	Farm Type Tractor W/Brush Hog Attachment	5.00	DY				487.85 97.57								487.85 97.57
8.00	51000005	Consumable Supplies	5.00	DY							500.00 100.00					500.00 100.00
9.00	2500MISC1	Miscellaneous Small Tools/Eqip	5.00	DY				250.00 50.00								250.00 50.00
10.00	51000105	Mechanics Tool Kit	5.00	DY							27.50 5.50					27.50 5.50
11.00	25000023	Gator ATV	10.00	DY				385.00 38.50								385.00 38.50
12.00	25000020	Pick-up Truck 4 x 4 w/fogm (2)	10.00	DY				528.00 52.80								528.00 52.80
13.00	25000019	Dump Truck 5 cy w/fogm	5.00	DY				357.50 71.50								357.50 71.50
14.00	51000103	Radio's	5.00	DY				137.50								137.50

TOAR - FUDS ()
Feasibility Study Cost Estimate
Worksheet: 0320 - Brush Clearing

Line	Resource	Description	Quantity	Unit	Manhours	Labor	Travel	Equipment	Subcontract	Internal	External	T & D	Bnd/Insr	(Not Used)	(Not Used)	Total Cost
								27.50								27.50
15.00	30000203	Schoenstedt	5.00	DY							57.50 11.50					57.50 11.50
16.00	25000011	Port -A- John (2)	5.00	DY				46.75 9.35								46.75 9.35
17.00	60000010	Per Diem	49.00	DY			5,145.00 105.00									5,145.00 105.00
		Worksheet Header	1.00	WK	350.00	18,352.50	5,145.00	2,605.10			585.00					26,687.60
		Sheet Totals			350.00	18,352.50	5,145.00	2,605.10			585.00					26,687.60

TOAR - FUDS ()
Feasibility Study Cost Estimate
Worksheet: 0400 - Surface MEC Removal

Worksheet Header: **Quantity:** 1.00 **Unit:** WK **Estimator:** DM **Revision:** **Rev. Date:** **Start Date:** **End Date:**

Work Codes

01.00 WSB 01A030 Alt. 3 SR Atomic-Vapor Hand Excavation

Formula Variables

Global Variables

Notes

5 - 10 hour days
Per Diem at 7 days per week

Line	Resource	Description	Quantity	Unit	Manhours	Labor	Travel	Equipment	Subcontract	Internal	External	T & D	Bnd/Insr	(Not Used)	(Not Used)	Total Cost
1.00	11000021	UXO Technician II (6)	300.00	HR	300.00 1.00	18,315.00 61.05										18,315.00 61.05
2.00	11000022	UXO Technician III	50.00	HR	50.00 1.00	3,658.50 73.17										3,658.50 73.17
3.00	25000020	Pick-up Truck 4 x 4 w/fogm (2)	10.00	DY				528.00 52.80								528.00 52.80
4.00	51000005	Consumable Supplies	5.00	DY							500.00 100.00					500.00 100.00
5.00	30000203	Schoenstedt (6)	30.00	DY							345.00 11.50					345.00 11.50
6.00	51000013	GPS - Hand Held	5.00	DY							302.50 60.50					302.50 60.50
7.00	25000011	Port -A- John (2)	5.00	DY				46.75 9.35								46.75 9.35
8.00	60000010	Per Diem	49.00	DY			5,145.00 105.00									5,145.00 105.00
9.00	30000202	Hand Held PDA (2)	5.00	DY							275.00 55.00					275.00 55.00
10.00	51000103	Radio's	5.00	DY				137.50 27.50								137.50 27.50
11.00	25000007	Computer	5.00	DY				57.50 11.50								57.50 11.50
12.00	51000101	Misc. H & S Equipment	5.00	DY						250.00 50.00						250.00 50.00

TOAR - FUDS ()
Feasibility Study Cost Estimate
Worksheet: 0400 - Surface MEC Removal

Line	Resource	Description	Quantity	Unit	Manhours	Labor	Travel	Equipment	Subcontract	Internal	External	T & D	Bnd/Insr	(Not Used)	(Not Used)	Total Cost
		Worksheet Header	1.00	WK	350.00	21,973.50	5,145.00	769.75		250.00	1,422.50					29,560.75
		Sheet Totals			350.00	21,973.50	5,145.00	769.75		250.00	1,422.50					29,560.75

TOAR - FUDS ()
Feasibility Study Cost Estimate
Worksheet: 0410 - Sub - Surface MEC Removal (M&D)

Worksheet Header: **Quantity:** 1.00 **Unit:** WK **Estimator:** DM **Revision:** **Rev. Date:** **Start Date:** **End Date:**

Work Codes

01.00 WSB 01A030 Alt. 3 SR Atomic-Vapor Hand Excavation

Formula Variables

Global Variables

Notes

5 - 10 hour days
Per Diem at 7 days per week

Line	Resource	Description	Quantity	Unit	Manhours	Labor	Travel	Equipment	Subcontract	Internal	External	T & D	Bnd/Insr	(Not Used)	(Not Used)	Total Cost
1.00	11000003	Heavy Equipment Operator	50.00	HR	50.00 1.00	3,384.50 67.69										3,384.50 67.69
2.00	11000021	UXO Technician II (6)	300.00	HR	300.00 1.00	18,315.00 61.05										18,315.00 61.05
3.00	11000022	UXO Technician III	50.00	HR	50.00 1.00	3,658.50 73.17										3,658.50 73.17
4.00	25000020	Pick-up Truck 4 x 4 w/fogm (2)	10.00	DY				528.00 52.80								528.00 52.80
5.00	25000002	Universal Loader/Backhoe w/fogm	5.00	DY				302.50 60.50								302.50 60.50
6.00	25000019	Dump Truck 5 cy w/fogm	5.00	DY				357.50 71.50								357.50 71.50
7.00	25000016	Trailer Flat Bed	5.00	DY				66.00 13.20								66.00 13.20
8.00	51000001	FOGM	100.00	GL							220.00 2.20					220.00 2.20
9.00	30000203	Schoenstedt (6)	30.00	DY							345.00 11.50					345.00 11.50
10.00	51000013	GPS - Hand Held	5.00	DY							302.50 60.50					302.50 60.50
11.00	25000011	Port -A- John (2)	5.00	DY				46.75 9.35								46.75 9.35
12.00	60000010	Per Diem	56.00	DY			5,880.00 105.00									5,880.00 105.00
13.00	30000202	Hand Held PDA (2)	5.00	DY							275.00 55.00					275.00 55.00
14.00	51000103	Radio's	5.00	DY				137.50 27.50								137.50 27.50

Line	Resource	Description	Quantity	Unit	Manhours	Labor	Travel	Equipment	Subcontract	Internal	External	T & D	Bnd/Insr	(Not Used)	(Not Used)	Total Cost
15.00	51000005	Consumable Supplies	5.00	DY							500.00 100.00					500.00 100.00
16.00	51000101	Misc. H & S Equipment	5.00	DY						250.00 50.00						250.00 50.00
17.00	51000007	Excavation Tool Kit	5.00	DY							275.00 55.00					275.00 55.00
		Worksheet Header	1.00	WK	400.00	25,358.00	5,880.00	1,438.25		250.00	1,917.50					34,843.75
		Sheet Totals			400.00	25,358.00	5,880.00	1,438.25		250.00	1,917.50					34,843.75

TOAR - FUDS ()
Feasibility Study Cost Estimate
Worksheet: 0420 - Geophysical Mapping (and Geo-mapping QC)

Worksheet Header: **Quantity:** 1.00 **Unit:** WK **Estimator:** DM **Revision:** **Rev. Date:** **Start Date:** **End Date:**

Work Codes

Formula Variables

Global Variables

Notes

5 - 10 hour days
Per Diem at 7 days per week

Line	Resource	Description	Quantity	Unit	Manhours	Labor	Travel	Equipment	Subcontract	Internal	External	T & D	Bnd/Insr	(Not Used)	(Not Used)	Total Cost
1.00	10000007	Geophysical Instrument Operator	50.00	HR	50.00 1.00	2,334.00 46.68										2,334.00 46.68
2.00	10000008	Associate Geoscientist	50.00	HR	50.00 1.00	2,917.00 58.34										2,917.00 58.34
3.00	11000014	Survey Party Chief	5.00	HR	5.00 1.00	235.50 47.10										235.50 47.10
4.00	11000021	UXO Technician II	50.00	HR	50.00 1.00	3,052.50 61.05										3,052.50 61.05
5.00	25000007	Computer	5.00	DY				57.50 11.50								57.50 11.50
6.00	25000010	Internet Service	5.00	DY					27.50 5.50							27.50 5.50
7.00	30000201	Magnetometer - 858	5.00	DY							687.50 137.50					687.50 137.50
8.00	25000026	USRAD	5.00	DY				1,200.00 240.00								1,200.00 240.00
9.00	51000005	Consumable Supplies	5.00	DY							500.00 100.00					500.00 100.00
10.00	51000103	Radio's	5.00	DY				137.50 27.50								137.50 27.50
11.00	25000009	Generator w/fogm	5.00	DY				209.00 41.80								209.00 41.80
12.00	30000205	GPS - RTK	5.00	DY							1,188.00 237.60					1,188.00 237.60
13.00	25000020	Pick-up Truck 4 x 4 w/fogm (2)	10.00	DY				528.00 52.80								528.00 52.80
14.00	60000010	Per Diem	21.00	DY			2,205.00 105.00									2,205.00 105.00

TOAR - FUDS ()
Feasibility Study Cost Estimate
Worksheet: 0420 - Geophysical Mapping (and Geo-mapping QC)

Line	Resource	Description	Quantity	Unit	Manhours	Labor	Travel	Equipment	Subcontract	Internal	External	T & D	Bnd/Insr	(Not Used)	(Not Used)	Total Cost
		Worksheet Header	1.00	WK	155.00	8,539.00	2,205.00	2,132.00	27.50		2,375.50					15,279.00
		Sheet Totals			155.00	8,539.00	2,205.00	2,132.00	27.50		2,375.50					15,279.00

TOAR - FUDS ()
Feasibility Study Cost Estimate
Worksheet: 0430 - Geophysical Data Analysis

Worksheet Header: **Quantity:** 1.00 **Unit:** WK **Estimator:** DM **Revision:** **Rev. Date:** **Start Date:** **End Date:**

Work Codes

Formula Variables

Global Variables

Notes

5 - 10 hour days
Per Diem at 7 days per week

Line	Resource	Description	Quantity	Unit	Manhours	Labor	Travel	Equipment	Subcontract	Internal	External	T & D	Bnd/Insr	(Not Used)	(Not Used)	Total Cost
1.00	11000002	Geophysicist Sr.	5.00	HR	5.00 1.00	495.00 99.00										495.00 99.00
2.00	11000001	Geophysical Operator	50.00	HR	50.00 1.00	2,944.50 58.89										2,944.50 58.89
3.00	11000016	IT Specialist	5.00	HR	5.00 1.00	322.30 64.46										322.30 64.46
4.00	11000017	CADD/GIS Operator	5.00	HR	5.00 1.00	225.30 45.06										225.30 45.06
5.00	25000005	Cell Phone	5.00	DY				23.40 4.68								23.40 4.68
6.00	25000007	Computer	5.00	DY				57.50 11.50								57.50 11.50
7.00	25000010	Internet Service	5.00	DY					27.50 5.50							27.50 5.50
8.00	25000012	Printer	5.00	DY				57.50 11.50								57.50 11.50
9.00	25000022	SUV 4x4 w/fogm	5.00	DY				429.00 85.80								429.00 85.80
10.00	51000005	Consumable Supplies	5.00	DY							500.00 100.00					500.00 100.00
11.00	5100PHN1	Project Phone Service	5.00	DY							57.50 11.50					57.50 11.50
12.00	60000010	Per Diem	7.00	DY			735.00 105.00									735.00 105.00

TOAR - FUDS ()
Feasibility Study Cost Estimate
Worksheet: 0430 - Geophysical Data Analysis

Line	Resource	Description	Quantity	Unit	Manhours	Labor	Travel	Equipment	Subcontract	Internal	External	T & D	Bnd/Insr	(Not Used)	(Not Used)	Total Cost
		Worksheet Header	1.00	WK	65.00	3,987.10	735.00	567.40	27.50		557.50					5,874.50
		Sheet Totals			65.00	3,987.10	735.00	567.40	27.50		557.50					5,874.50

TOAR - FUDS ()
Feasibility Study Cost Estimate
Worksheet: 0440 - Anomaly Re-Acquisition

Worksheet Header: **Quantity:** 1.00 **Unit:** WK **Estimator:** DM **Revision:** **Rev. Date:** **Start Date:** **End Date:**

Work Codes

Formula Variables

Global Variables

Notes

5 - 10 hour days
Per Diem at 7 days per week

Line	Resource	Description	Quantity	Unit	Manhours	Labor	Travel	Equipment	Subcontract	Internal	External	T & D	Bnd/Insr	(Not Used)	(Not Used)	Total Cost
1.00	11000013	Survey Technician	50.00	HR	50.00 1.00	1,905.00 38.10										1,905.00 38.10
2.00	11000021	UXO Technician II	50.00	HR	50.00 1.00	3,052.50 61.05										3,052.50 61.05
3.00	51000005	Consumable Supplies	5.00	DY							500.00 100.00					500.00 100.00
4.00	30000205	GPS - RTK	5.00	DY							1,188.00 237.60					1,188.00 237.60
5.00	30000201	Magnetometer - 858	5.00	DY							687.50 137.50					687.50 137.50
6.00	25000026	USRAD	5.00	DY				1,200.00 240.00								1,200.00 240.00
7.00	51000103	Radio's	5.00	DY				137.50 27.50								137.50 27.50
8.00	30000203	Schoenstedt	5.00	DY							57.50 11.50					57.50 11.50
9.00	25000022	SUV 4x4 w/fogm	5.00	DY				429.00 85.80								429.00 85.80
10.00	25000014	Surveyors Kit	5.00	DY				550.00 110.00								550.00 110.00
11.00	60000010	Per Diem	14.00	DY			1,470.00 105.00									1,470.00 105.00
		Worksheet Header	1.00	WK	100.00	4,957.50	1,470.00	2,316.50			2,433.00					11,177.00
		Sheet Totals			100.00	4,957.50	1,470.00	2,316.50			2,433.00					11,177.00

TOAR - FUDS ()
Feasibility Study Cost Estimate
Worksheet: 0450 - Sub - Surface MEC Removal (DGM Picks)

Worksheet Header: **Quantity:** 1.00 **Unit:** WK **Estimator:** DM **Revision:** **Rev. Date:** **Start Date:** **End Date:**

Work Codes

01.00 WSB 01A030 Alt. 3 SR Atomic-Vapor Hand Excavation

Formula Variables

Global Variables

Notes

5 - 10 hour days
Per Diem at 7 days per week

Line	Resource	Description	Quantity	Unit	Manhours	Labor	Travel	Equipment	Subcontract	Internal	External	T & D	Bnd/Insr	(Not Used)	(Not Used)	Total Cost
1.00	11000003	Heavy Equipment Operator	50.00	HR	50.00 1.00	3,384.50 67.69										3,384.50 67.69
2.00	11000021	UXO Technician II (6)	300.00	HR	300.00 1.00	18,315.00 61.05										18,315.00 61.05
3.00	11000022	UXO Technician III	50.00	HR	50.00 1.00	3,658.50 73.17										3,658.50 73.17
4.00	25000020	Pick-up Truck 4 x 4 w/fogm (2)	10.00	DY				528.00 52.80								528.00 52.80
5.00	25000002	Universal Loader/Backhoe w/fogm	5.00	DY				302.50 60.50								302.50 60.50
6.00	25000019	Dump Truck 5 cy w/fogm	5.00	DY				357.50 71.50								357.50 71.50
7.00	25000016	Trailer Flat Bed	5.00	DY				66.00 13.20								66.00 13.20
8.00	51000001	FOGM	100.00	GL							220.00 2.20					220.00 2.20
9.00	30000203	Schoenstedt (6)	30.00	DY							345.00 11.50					345.00 11.50
10.00	51000013	GPS - Hand Held	5.00	DY							302.50 60.50					302.50 60.50
11.00	25000011	Port -A- John (2)	5.00	DY				46.75 9.35								46.75 9.35
12.00	60000010	Per Diem	56.00	DY			5,880.00 105.00									5,880.00 105.00
13.00	30000202	Hand Held PDA (2)	5.00	DY							275.00 55.00					275.00 55.00
14.00	51000103	Radio's	5.00	DY				137.50 27.50								137.50 27.50

TOAR - FUDS ()
Feasibility Study Cost Estimate
Worksheet: 0450 - Sub - Surface MEC Removal (DGM Picks)

Line	Resource	Description	Quantity	Unit	Manhours	Labor	Travel	Equipment	Subcontract	Internal	External	T & D	Bnd/Insr	(Not Used)	(Not Used)	Total Cost
15.00	51000005	Consumable Supplies	5.00	DY							500.00 100.00					500.00 100.00
16.00	51000101	Misc. H & S Equipment	5.00	DY						250.00 50.00						250.00 50.00
17.00	51000007	Excavation Tool Kit	5.00	DY							275.00 55.00					275.00 55.00
		Worksheet Header	1.00	WK	400.00	25,358.00	5,880.00	1,438.25		250.00	1,917.50					34,843.75
		Sheet Totals			400.00	25,358.00	5,880.00	1,438.25		250.00	1,917.50					34,843.75

TOAR - FUDS ()
Feasibility Study Cost Estimate
Worksheet: 0500 - MEC Disposal

Worksheet Header: **Quantity:** 1.00 **Unit:** WK **Estimator:** DM **Revision:** **Rev. Date:** **Start Date:** **End Date:**

Work Codes

01.00 WSB 01A030 Alt. 3 SR Atomic-Vapor Hand Excavation

Formula Variables

Global Variables

Notes

5 - 10 hour days
Per Diem at 7 days per week

Line	Resource	Description	Quantity	Unit	Manhours	Labor	Travel	Equipment	Subcontract	Internal	External	T & D	Bnd/Insr	(Not Used)	(Not Used)	Total Cost
1.00	11000021	UXO Technician II	200.00	HR	200.00 1.00	12,210.00 61.05										12,210.00 61.05
2.00	11000022	UXO Technician III	50.00	HR	50.00 1.00	3,658.50 73.17										3,658.50 73.17
3.00	25000020	Pick-up Truck 4 x 4 w/fogm (2)	10.00	DY				528.00 52.80								528.00 52.80
4.00	25000023	Gator ATV (2)	10.00	DY				385.00 38.50								385.00 38.50
5.00	51000001	FOGM	50.00	GL							110.00 2.20					110.00 2.20
6.00	60000010	Per Diem	35.00	DY			3,675.00 105.00									3,675.00 105.00
7.00	30000202	Hand Held PDA (2)	5.00	DY							275.00 55.00					275.00 55.00
8.00	51000103	Radio's	5.00	DY				137.50 27.50								137.50 27.50
9.00	51000100	Miscellaneous ODCs (pic's and shovels)	5.00	DY							250.00 50.00					250.00 50.00
10.00	51000101	Misc. H & S Equipment	5.00	DY						250.00 50.00						250.00 50.00
11.00	51000104	Explosives Materials	5.00	DY							82.50 16.50					82.50 16.50
12.00	25000024	Explosives Vehicle	5.00	DY				357.50 71.50								357.50 71.50
13.00	25000025	Blasting Machine	5.00	DY				82.50 16.50								82.50 16.50

TOAR - FUDS ()
Feasibility Study Cost Estimate
Worksheet: 0500 - MEC Disposal

Line	Resource	Description	Quantity	Unit	Manhours	Labor	Travel	Equipment	Subcontract	Internal	External	T & D	Bnd/Insr	(Not Used)	(Not Used)	Total Cost
		Worksheet Header	1.00	WK	250.00	15,868.50	3,675.00	1,490.50		250.00	717.50					22,001.50
		Sheet Totals			250.00	15,868.50	3,675.00	1,490.50		250.00	717.50					22,001.50

TOAR - FUDS ()
Feasibility Study Cost Estimate
Worksheet: 0510 - Scrap Disposal

Worksheet Header: **Quantity:** 1.00 **Unit:** WK **Estimator:** DM **Revision:** **Rev. Date:** **Start Date:** **End Date:**

Work Codes

01.00 WSB 01A030 Alt. 3 SR Atomic-Vapor Hand Excavation

Formula Variables

Global Variables

Notes

5 - 10 hour days
Per Diem at 7 days per week

Line	Resource	Description	Quantity	Unit	Manhours	Labor	Travel	Equipment	Subcontract	Internal	External	T & D	Bnd/Insr	(Not Used)	(Not Used)	Total Cost
1.00	11000021	UXO Technician II	200.00	HR	200.00 1.00	12,210.00 61.05										12,210.00 61.05
2.00	11000022	UXO Technician III	50.00	HR	50.00 1.00	3,658.50 73.17										3,658.50 73.17
3.00	25000020	Pick-up Truck 4 x 4 w/fogm (2)	10.00	DY				528.00 52.80								528.00 52.80
4.00	25000023	Gator ATV (2)	10.00	DY				385.00 38.50								385.00 38.50
5.00	51000001	FOGM	50.00	GL							110.00 2.20					110.00 2.20
6.00	60000010	Per Diem	35.00	DY			3,675.00 105.00									3,675.00 105.00
7.00	30000202	Hand Held PDA (2)	5.00	DY							275.00 55.00					275.00 55.00
8.00	51000103	Radio's	5.00	DY				137.50 27.50								137.50 27.50
9.00	51000100	Miscellaneous ODCs (pic's and shovels)	5.00	DY							250.00 50.00					250.00 50.00
10.00	30000035	Recycler - Scrap Disposal	5.00	DY					1,200.00 240.00							1,200.00 240.00
		Worksheet Header	1.00	WK	250.00	15,868.50	3,675.00	1,050.50	1,200.00		635.00					22,429.00
		Sheet Totals			250.00	15,868.50	3,675.00	1,050.50	1,200.00		635.00					22,429.00

TOAR - FUDS ()
Feasibility Study Cost Estimate
Worksheet: 0600 - Site Restoration

Worksheet Header: **Quantity:** 1.00 **Unit:** WK **Estimator:** DM **Revision:** **Rev. Date:** **Start Date:** **End Date:**

Work Codes

01.00 WSB 01A030 Alt. 3 SR Atomic-Vapor Hand Excavation

Formula Variables

Global Variables

Notes

(2) Laborers required to fill and compact holes left from anomily removal.

Line	Resource	Description	Quantity	Unit	Manhours	Labor	Travel	Equipment	Subcontract	Internal	External	T & D	Bnd/Insr	(Not Used)	(Not Used)	Total Cost
1.00	11000005	Laborer (2)	100.00	HR	100.00 1.00	4,668.00 46.68										4,668.00 46.68
2.00	25000020	Pick-up Truck 4 x 4 w/fogm	5.00	DY				264.00 52.80								264.00 52.80
3.00	2500MISC1	Miscellaneous Small Tools/Eqip	5.00	DY				250.00 50.00								250.00 50.00
4.00	51000010	Fill Materials	50.00	CY							575.00 11.50					575.00 11.50
5.00	60000010	Per Diem	14.00	DY			1,470.00 105.00									1,470.00 105.00
		Worksheet Header	1.00	WK	100.00	4,668.00	1,470.00	514.00			575.00					7,227.00
		Sheet Totals			100.00	4,668.00	1,470.00	514.00			575.00					7,227.00

TOAR - FUDS ()
Feasibility Study Cost Estimate
Worksheet: 0610 - Demobilization

Worksheet Header: **Quantity:** 1.00 **Unit:** LS **Estimator:** DM **Revision:** **Rev. Date:** **Start Date:** **End Date:**

Work Codes | **Formula Variables** | **Notes**

01.00 WSB 01A030 Alt. 3 SR Atomic-Vapor Hand Excavation | Global Variables

Line	Resource	Description	Quantity	Unit	Manhours	Labor	Travel	Equipment	Subcontract	Internal	External	T & D	Bnd/Insr	(Not Used)	(Not Used)	Total Cost
1.00	3000SBMZ	Subcontract: Demobilization	10.00	EA					5,500.00							5,500.00
		Miscellanous Equipment							550.00							550.00
2.00	51000100	Miscellaneous ODCs	5.00	DY							250.00					250.00
											50.00					50.00
3.00	60000009	Demobilization Allowance per person	30.00	EA							30,000.00					30,000.00
											1,000.00					1,000.00
		Worksheet Header	1.00	LS					5,500.00		30,250.00					35,750.00
		Sheet Totals							5,500.00		30,250.00					35,750.00

TOAR - FUDS ()
Feasibility Study Cost Estimate
Worksheet: 0700 - Final Report

Worksheet Header: **Quantity:** 1.00 **Unit:** LS **Estimator:** DM **Revision:** **Rev. Date:** **Start Date:** **End Date:**

Work Codes | **Formula Variables** | **Notes**

01.00 WSB 01A030 Alt. 3 SR Atomic-Vapor Hand Excavation | Global Variables

Line	Resource	Description	Quantity	Unit	Manhours	Labor	Travel	Equipment	Subcontract	Internal	External	T & D	Bnd/Insr	(Not Used)	(Not Used)	Total Cost
1.00	30000104	Final Report	1.00	LS					50,000.00 50,000.00							50,000.00 50,000.00
		Worksheet Header	1.00	LS					50,000.00							50,000.00
		Sheet Totals							50,000.00							50,000.00

TOAR - FUDS ()
Feasibility Study Cost Estimate
Worksheet: 0800 - Land Use Controls

Worksheet Header: **Quantity:** 1.00 **Unit:** LS **Estimator:** DM **Revision:** **Rev. Date:** **Start Date:** **End Date:**

Work Codes **Formula Variables** **Notes**

Global Variables

Line	Resource	Description	Quantity	Unit	Manhours	Labor	Travel	Equipment	Subcontract	Internal	External	T & D	Bnd/Insr	(Not Used)	(Not Used)	Total Cost
1.00	30000105	Signs	100.00	EA					10,000.00 100.00							10,000.00 100.00
2.00	30000106	Permitting	1.00	LS					2,000.00 2,000.00							2,000.00 2,000.00
3.00	30000107	Brochure/Fact Sheet (includes cost for information package)	1.00	LS					13,000.00 13,000.00							13,000.00 13,000.00
4.00	30000108	Prepare and Distribute Videos/DVDs	1.00	LS					26,000.00 26,000.00							26,000.00 26,000.00
5.00	30000109	Update Websites	1.00	LS					5,000.00 5,000.00							5,000.00 5,000.00
6.00	30000110	TRC (per meeting)	1.00	LS					5,000.00 5,000.00							5,000.00 5,000.00
7.00	30000111	Reverse 911 System (shared cost)	1.00	LS					25,000.00 25,000.00							25,000.00 25,000.00
		Worksheet Header	1.00	LS					86,000.00							86,000.00
		Sheet Totals							86,000.00							86,000.00

TOAR - FUDS ()
Feasibility Study Cost Estimate
Worksheet: 0900 - Land Use Controls - Annual Cost

Worksheet Header: **Quantity:** 1.00 **Unit:** YR **Estimator:** DM **Revision:** **Rev. Date:** **Start Date:** **End Date:**

Work Codes **Formula Variables** **Notes**

Global Variables

Line	Resource	Description	Quantity	Unit	Manhours	Labor	Travel	Equipment	Subcontract	Internal	External	T & D	Bnd/Insr	(Not Used)	(Not Used)	Total Cost
1.00	30000105	Signs	10.00	EA					1,000.00 100.00							1,000.00 100.00
2.00	30000116	Permitting	1.00	LS					500.00 500.00							500.00 500.00
3.00	30000117	Brochure/Fact Sheet (includes cost for information package)	1.00	LS					1,000.00 1,000.00							1,000.00 1,000.00
4.00	30000118	Prepare and Distribute Vidoes/DVDs	1.00	LS					2,000.00 2,000.00							2,000.00 2,000.00
5.00	30000119	Update Websites	1.00	LS					1,000.00 1,000.00							1,000.00 1,000.00
6.00	30000120	TRC (per meeting)	1.00	LS					2,000.00 2,000.00							2,000.00 2,000.00
7.00	30000121	Reverse 911 System (shared cost)	1.00	LS					2,000.00 2,000.00							2,000.00 2,000.00
		Worksheet Header	1.00	YR					9,500.00							9,500.00
		Sheet Totals							9,500.00							9,500.00

TOAR - FUDS ()
Feasibility Study Cost Estimate
Worksheet: 0910 - Construction Support

Worksheet Header: **Quantity:** 1.00 **Unit:** WK **Estimator:** DM **Revision:** **Rev. Date:** **Start Date:** **End Date:**

Work Codes

01.00 WSB 01A030 Alt. 3 SR Atomic-Vapor Hand Excavation

Formula Variables

Global Variables

Notes

5 - 10 hour days
Per Diem at 7 days per week

Line	Resource	Description	Quantity	Unit	Manhours	Labor	Travel	Equipment	Subcontract	Internal	External	T & D	Bnd/Insr	(Not Used)	(Not Used)	Total Cost
1.00	11000021	UXO Technician II (2)	100.00	HR	100.00 1.00	6,105.00 61.05										6,105.00 61.05
2.00	25000020	Pick-up Truck 4 x 4 w/fogm (2)	10.00	DY				528.00 52.80								528.00 52.80
3.00	51000005	Consumable Supplies	5.00	DY							500.00 100.00					500.00 100.00
4.00	30000203	Schoenstedt (2)	10.00	DY							115.00 11.50					115.00 11.50
5.00	51000013	GPS - Hand Held	5.00	DY							302.50 60.50					302.50 60.50
6.00	60000010	Per Diem	14.00	DY			1,470.00 105.00									1,470.00 105.00
		Worksheet Header	1.00	WK	100.00	6,105.00	1,470.00	528.00			917.50					9,020.50
		Sheet Totals			100.00	6,105.00	1,470.00	528.00			917.50					9,020.50

TOAR - FUDS ()
Feasibility Study Cost Estimate
Worksheet: 1000 - 5-Year Review - First Review

Worksheet Header: **Quantity:** 1.00 **Unit:** LS **Estimator:** DM **Revision:** **Rev. Date:** **Start Date:** **End Date:**

Work Codes **Formula Variables** **Notes**

Global Variables

Line	Resource	Description	Quantity	Unit	Manhours	Labor	Travel	Equipment	Subcontract	Internal	External	T & D	Bnd/Insr	(Not Used)	(Not Used)	Total Cost
1.00	30000112	Recurring Review Plan	1.00	EA					15,000.00 15,000.00							15,000.00 15,000.00
2.00	30000113	Document Reviews	1.00	EA					5,000.00 5,000.00							5,000.00 5,000.00
3.00	30000114	Site Inspection	1.00	EA					10,000.00 10,000.00							10,000.00 10,000.00
4.00	30000115	Report	1.00	EA					7,500.00 7,500.00							7,500.00 7,500.00
		Worksheet Header	1.00	LS					37,500.00							37,500.00
		Sheet Totals							37,500.00							37,500.00

TOAR - FUDS ()
Feasibility Study Cost Estimate
Worksheet: 1010 - 5-Year Review - Remaining Reviews

Worksheet Header: **Quantity:** 1.00 **Unit:** LS **Estimator:** DM **Revision:** **Rev. Date:** **Start Date:** **End Date:**

Work Codes **Formula Variables** **Notes**

Global Variables

Line	Resource	Description	Quantity	Unit	Manhours	Labor	Travel	Equipment	Subcontract	Internal	External	T & D	Bnd/Insr	(Not Used)	(Not Used)	Total Cost
1.00	30000113	Document Reviews	1.00	EA					5,000.00 5,000.00							5,000.00 5,000.00
2.00	30000114	Site Inspection	1.00	EA					10,000.00 10,000.00							10,000.00 10,000.00
3.00	30000115	Report	1.00	EA					7,500.00 7,500.00							7,500.00 7,500.00
		Worksheet Header	1.00	LS					22,500.00							22,500.00
		Sheet Totals							22,500.00							22,500.00