Draft

Feasibility Study for RVAAP-016-R-01 Fuze and Booster Quarry MRS Version 1.0

Former Ravenna Army Ammunition Plant
Portage and Trumbull Counties, Ohio

Contract No. W912DR-15-D-0016
Delivery Order No. 0001

Prepared for:

US Army Corps of Engineers

North Atlantic Division, Baltimore District
10 S. Howard Street, Room 7000
Baltimore, MD 21201

Prepared by:

HydroGeoLogic, Inc.
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Reston, Virginia 20190

June 2, 2017

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This Draft Feasibility Study for RVAAP-016-R-01 Fuze and Booster Quarry Munitions Response Site (MRS) is submitted in support of the Multiple Award Military Munitions Services (MAMMS) Contract No. W912DR-15-D-0016, Task Order 0001. The objective of this FS is to develop, evaluate, and compare remedial action alternatives that will meet the remedial action objectives for the MRS so that the Department of Defense can select and propose an appropriate remedy. This FS used the information obtained during the Remedial Investigation to determine appropriate remedial actions based on the current and anticipated future land uses of the MRS.

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RVAAP-016-R-01 Fuze and Booster Quarry MRS

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ARNG – Army National Guard
COR – Contracting Officer's Representative
IED – Installation and Environmental Division
OHARNG – Ohio Army National Guard
RVAAP – Former Ravenna Army Ammunition Plant
USACE – United States Army Corps of Engineers

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CONTRACTOR'S STATEMENT OF INDEPENDENT TECHNICAL REVIEW

HydroGeoLogic, Inc. (HGL) has completed the *Draft Feasibility Study for RVAAP-016-R-01 Fuze and Booster Quarry MRS,* for the former Ravenna Army Ammunition Plant, Portage and Trumbull Counties, Ohio. Notice is hereby given that an independent technical review has been conducted that is appropriate to the level of risk and complexity inherent in the project. During the independent technical review, compliance with established policy principles and procedures, utilizing justified and valid assumptions, was verified. This included review of data quality objectives; technical assumptions; methods, procedures, and materials to be used; the appropriateness of data used and level of data obtained; and reasonableness of the results, including whether the product meets customer's needs consistent with law and existing USACE policy.

Reviewed/Approved by: Janardan J Patel Digitally signed by Janardan J Patel DN: cn=Janardan J Patel, o=HGL, ou=ECD, email=jpatel@hgl.com, c=US Date: 2017.06.01 09:02:35 -04'00' Date: June 2, 2017

Janardan Patel, PMP
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Prepared/Approved by: Kimberly Vaughn Date: June 2, 2017

Kimberly Vaughn
Project Manager

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AC	Advanced Classification
AEDB-R	Army Environmental Database - Restoration Module
AOC	area of concern
ARAR	applicable or relevant and appropriate requirements
ARNG	Army National Guard
ASR	Archives Search Report
bgs	below ground surface
BIP	blow-in-place
Camp Ravenna	Camp Ravenna Joint Military Training Center
CB&I	CB&I Federal Services, LLC
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COC	contaminant of concern
COR	Contracting Officer's Representative
CSM	conceptual site model
DDESB	Department of Defense Explosives Safety Board
DERP	Defense Environmental Response Program
DFFO	Director's Final Findings and Orders
DGM	digital geophysical mapping
DoD	U.S. Department of Defense
EM	electromagnetic
EZ	exclusion zone
FS	Feasibility Study
GRA	general response action
HA	hazard assessment
HFD	hazardous fragment distance
HGL	HydroGeoLogic, Inc.
HRR	Historical Records Review
INRMP	Integrated Natural Resources Management Plan
IRP	Installation Restoration Program
ISM	incremental sampling methodology
LTM	long-term management
LUC	land use control
MC	munitions constituents
MDAS	material documented as safe
MDEH	material documented as an explosive hazard
MEC	munitions and explosives of concern
MFD-H	maximum fragment distance, horizontal
mm	millimeter
MMRP	Military Munitions Response Program
MPPEH	material potentially presenting an explosive hazard
MRS	munitions response site
NCP	National Oil and Hazardous Substances Contingency Plan
NEPA	National Environmental Policy Act
NPDES	National Pollutant Discharge Elimination System

O&M	operation and maintenance
OAC	Ohio Administrative Code
OHARNG	Ohio Army National Guard
Ohio EPA	Ohio Environmental Protection Agency
OSWER	Office of Solid Waste and Emergency Response
PCB	polychlorinated biphenyl
RAO	remedial action objective
RI	Remedial Investigation
ROD	Record of Decision
RVAAP	Former Ravenna Army Ammunition Plant
SAIC	Science Applications International Corporation
SI	Site Inspection
SRC	site-related chemical
SVOC	semivolatile organic compound
TBC	to be considered
USACE	U.S. Army Corps of Engineers
USC	United States Code
USEPA	U.S. Environmental Protection Agency
USP&FO	U.S. Property and Fiscal Officer
UU/UE	unlimited use/unrestricted exposure
UXO	unexploded ordnance

EXECUTIVE SUMMARY

Introduction

HydroGeoLogic, Inc. (HGL) has been contracted by the U. S. Army Corps of Engineers (USACE), North Atlantic Division, Baltimore District, to complete a Feasibility Study (FS) for the Fuze and Booster Quarry Munitions Response Site (MRS) (RVAAP-016-R-01) at the Former Ravenna Army Ammunition Plant (RVAAP) in Portage and Trumbull Counties, Ohio. This FS is being prepared under Delivery Order No. 0001 of *Multiple Award Military Munitions Services Performance-Based Acquisition* Contract No. W912DR-15-D-0016. The delivery order was issued by the USACE, Baltimore District, on August 26, 2016.

This FS was developed to evaluate remedial action alternatives that address the explosive hazards present at the MRS and are protective of human and environmental receptors in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). This FS evaluates the necessary CERCLA remediation requirements with respect to material potentially presenting an explosive hazard (MPPEH) at the Fuze and Booster Quarry.

Fuze and Booster Quarry MRS History and Background

The Fuze and Booster Quarry MRS comprises 4.92 acres within RVAAP. The MRS is located south of Newton Falls Road and north of Fuze and Booster Road. The Fuze and Booster Quarry was a stone and ballast quarry excavated to provide building material for RVAAP. The quarry was used from 1945 until 1949 as an open burn area where sawdust waste generated at Load Lines 6 and 11 was thermally treated. Thereafter, the quarry was used as a landfill that reportedly accepted fuze and booster assemblies, projectiles, residual ash, and sanitary waste. In 1976, the landfill materials, inclusive of the munitions-related items historically disposed of at the MRS, were removed and transferred to either Ramsdell Quarry or one of the other burning grounds at RVAAP. Around this time three elongated ponds were constructed at the MRS for use as settling ponds. From 1987 through 1993, spent brine regenerate and sand filtration backwash water were discharged to the ponds from the facility's potable water treatment system. This discharge was regulated under a National Pollutant Discharge Elimination System (NPDES) permit. The ponds have been inactive since 1993 (e2M, 2007).

The current configuration of the MRS consists of the three elongated ponds situated end to end and separated by earthen berms. The surface water in the ponds is approximately 15 to 20 feet below the surrounding grade, and the depths of the water in the ponds fluctuate depending on the seasons and amount of precipitation. The southern two quarry ponds are filled with water year-round. Water is typically present in the northern pond; however, water levels can vary widely, and sometimes no water is present during very dry periods. The ponds are surrounded by a mature hardwood forest, and a gravel road leads up to the western side of the MRS.

Facility personnel have stated that any type of munitions produced when the facility was in operation may have been destroyed at the MRS. These munitions may have included rockets, bombs, fuzes, detonators, flares, missiles, grenades, landmines, medium- and large-caliber projectiles, explosives, mortars, propellants, practice ordnance, pyrotechnics, and small arms.

Current activities at the Fuze and Booster Quarry MRS include maintenance and natural resource management activities. While maintenance and natural resource management activities will continue at the site, the future land use for the MRS is for military training and hunting/fishing, which is preferably assessed using the Commercial/Industrial Land Use Exposure Scenario and Industrial Receptor as the Representative Receptor.

USACE completed a Remedial Investigation (RI) at the Fuze and Booster Quarry MRS in June 2015. No MPPEH verified as material documented as an explosive hazard (MDEH) was found at the MRS during the RI; however, MPPEH verified as material documented as safe (MDAS) was encountered. The MDAS were solid and/or inert and did not pose an explosive safety hazard. Because no MDEH was found during the intrusive investigation and the statistical approach used to select the number of anomalies to investigate, the RI concluded that there is a low probability that MPPEH is present in the anomalies not intrusively investigated within the terrestrial portions of the MRS. Only cultural debris (i.e., trash cans, metal pipes, sheet metal, etc.) were observed within the ponds; no MDEH, MPPEH, MD or other munitions-related debris was observed in the ponds. No explosive hazards were found during the RI; therefore, no munitions and explosives of concern (MEC) hazard assessment (HA) was required for the MRS. However, because MDAS was found within the MRS, the RI concluded that there is a low probability that MPPEH is present at the MRS. An FS was recommended to assess remedial alternatives for addressing residual MPPEH in the terrestrial portion of the MRS.

The ecological risk assessment conducted as part of the RI determined that ecological receptors in the aquatic environment could be affected by site-related chemicals in wet sediment. The chemicals of concern identified during previous investigations under the Installation Restoration Program (IRP) at the MRS will continue to be addressed under the IRP. No MC risk was identified in the human health risk assessment. Therefore, the results of the RI fieldwork concluded no MC risk exists at the MRS

Problem Identification

Although no MDEH was found during the RI, the use or introduction of munitions at the MRS is confirmed. Based on the historical use of the MRS as a former landfill that reportedly accepted munitions and MPPEH found during the RI field work, the potential remains for residual MPPEH to be present on the surface and in the subsurface at the MRS. The presence of MPPEH at the MRS represents a potential exposure risk to the Industrial Receptor that has a maximum exposure depth of 4 feet bgs.

Remedial Action Objectives

The Remedial Action Objectives (RAOs) are developed to determine the effectiveness of the remedial action based on the conceptual site model (CSM) for the MRS, and are focused on limiting or removing exposure pathways for MPPEH (U.S. Army, 2009). RAOs specify the contaminant(s) and media of concern, potential exposure pathways, and remediation goals [40 CFR 300.430(e)(2)(i)]. The RAOs for the MRS address the overall goal of managing the residual explosive hazards and protecting human receptors from these hazards. The media of concern is surface soil between ground surface and 4 feet bgs, the maximum exposure depth determined for the Industrial Receptor. The following RAOs were developed for the Fuze and Booster Quarry MRS:

- Reduce the unacceptable hazard of MPPEH on the surface such that the likelihood of an Industrial Receptor encountering an explosive hazard via direct contact is negligible.

- Reduce the unacceptable hazard of MPPEH to a depth of 4 feet bgs such that the likelihood of an Industrial Receptor encountering an explosive hazard via direct contact is negligible.

Development of Screening Alternatives

This FS identifies and screens remedial technologies and associated process options that may be appropriate for satisfying the RAOs for the Fuze and Booster MRS. The evaluation of remedial technology types and process options is a two-step process. The first step is an initial screening of technologies and process options. This is generally done on the basis of technical implementability in order to eliminate process options or entire technology types that would clearly be ineffective or unworkable considering MRS and MPPEH hazards. The second step in this process is to evaluate the process options considered to be technically implementable in greater detail with respect to effectiveness, implementability, and cost in order to select the representative process for each technology type. Although these are the same criteria used to screen remedial alternatives prior to detailed analysis, at this stage these criteria are applied only to technologies and process options and not to MRS-wide alternatives. Select remedial technologies and process options were carried forward after the evaluation of the remedial technologies types and process options and were combined to develop the following remedial alternatives for the MRS:

Alternative 1: No Action - The *National Oil and Hazardous Substances Pollution Contingency Plan* (NCP) [40 Code of Federal Regulations (CFR) Part 300] requires that a No Action alternative be evaluated to provide a baseline for comparison to other alternatives. This alternative provides no actions to protect potential human receptors at the MRS.

Alternative 2: Land Use Controls (LUC) – Under this alternative, no action would be taken to reduce any potential hazards to human receptors. Toxicity concerns associated with MPPEH would be reduced when any MPPEH (confirmed to be MDEH) is reported to Camp Ravenna Range Control for demolition conducted by Explosive Ordnance Disposal personnel. Implementation of this alternative would not lead to Unlimited Use/Unrestricted Exposure (UU/UE) for the Industrial User at the MRS since subsurface MPPEH would remain. LUCs would be implemented and would focus on reducing potential human exposure to MPPEH by managing the activities occurring at the MRS.

Alternative 3: Surface MPPEH Removal and LUCs - This alternative includes the systematic search and removal of all MPPEH on or just below the ground surface using hand-held analog instruments. Implementation of this alternative would not lead to UU/UE for the Industrial User at the MRS since subsurface MPPEH would remain. Toxicity concerns associated with MPPEH would be reduced through MPPEH removal. LUCs would be required to be implemented to controls behaviors and protect receptors from residual MPPEH in the subsurface.

Alternative 4: Surface and Subsurface MPPEH Removal (UU/UE) - This alternative conservatively includes the systematic search and removal of all MPPEH that is protective of the Industrial Receptor to 4 feet bgs utilizing full-coverage digital geophysical mapping and manual excavation of target anomalies. Toxicity concerns associated with MPPEH would be reduced through MPPEH removal. Successful completion of this alternative would achieve UU/UE at the MRS.

Once the remedial alternatives were assembled, they were described and preliminarily screened against the three criteria of effectiveness, implementability and cost. Evaluations of Alternatives 1, 2, and 4 indicated that they met the three criteria and were retained for further detailed analysis. Alternative 3 was removed from further consideration since it met the same effectiveness and implementability as Alterative 2, but at greater cost.

A detailed analysis was completed for each retained alternative using the nine evaluation criteria, as defined by the NCP. Table ES-1 summarizes the comparative analysis of the alternatives against the nine evaluation criteria, as presented in this FS. The purpose of the detailed analysis was to evaluate and compare the identified remedial alternatives and to develop a proposed plan for regulatory and public review.

Evaluation of Screening Alternatives

To date, all MPPEH found at the Fuze and Booster Quarry MRS has been verified as MDAS; however, based on the historical use of the MRS as a former landfill and because MPPEH was found during the RI field work, the potential remains for residual MPPEH to be present on the surface and in the subsurface at the MRS. Exposure to MPPEH is a human health concern and the presence of MPPEH at the MRS represents a potential exposure risk to the Industrial Receptor that has a maximum exposure depth of 4 feet bgs. The NCP statutory preference for reduction of toxicity, mobility, or volume through treatment is best achieved with Alternative 4, which allows for UU/UE. Based on the evaluation of NCP criteria Alternative 2 (LUCs) and Alternative 4 (Surface and Subsurface MPPEH Removal [UU/UE]) appear to be acceptable and implementable. The deciding factor will be the lowest cost alternative that meets the RAOs and is also technically and administratively implementable. .

Using the comparative analysis of the alternatives presented in this FS, a preferred alternative will be presented to the public in the Proposed Plan for this MRS for review and comment. A remedy will then be selected for this MRS and be presented in the Record of Decision.

145 Table ES-1. Comparison of Alternatives

CERCLA Evaluation Criteria	Remedial Alternatives		
	Alternative 1 No Action	Alternative 2 LUCs	Alternative 4 Surface and Subsurface MPPEH Removal (UU/UE)
Protective of Human Health and Environment	No	Yes	Yes
Complies with ARARs	Yes	Yes	Yes
Effective and Permanent	Lowest	Medium	Highest
Reduces Toxicity, Mobility, or Volume by Treatment	None (no treatment)	Minimal (Incidental treatment)	Complete removal of MPPEH
Short-Term Effectiveness	Lowest	Medium	Highest
Implementable	Highest ease to implement	Easily implementable	Most difficult to implement
Costs (does not include 5-Year Reviews)			
Capital	$0	$20,445	$451,616
O&M (discounted)	$0	$56,227	$0
Total Present Worth	$0	$76,672	$451,616
Costs for 5-Year Reviews			
5-Year Reviews and Incidental Destruction of MDEH (Periodic Costs for 30 years, discounted)	$0	$128,141	$0

146 *ARAR denotes applicable or relevant and appropriate requirement.*
147 *LUC denotes Land Use Control*
148 *MPPEH denotes material potentially presenting and explosive hazard*
149 *O&M Operation and Maintenance*
150 *UU/UE denotes Unrestricted Use/Unrestricted Exposure*

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1.0 INTRODUCTION

HydroGeoLogic, Inc. (HGL) has been contracted by the U. S. Army Corps of Engineers (USACE), North Atlantic Division, Baltimore District, to complete a Feasibility Study (FS) for the Fuze and Booster Quarry Munitions Response Site (MRS) at the Former Ravenna Army Ammunition Plant (RVAAP) in Portage and Trumbull Counties, Ohio. This FS is being prepared under Delivery Order No. 0001 of *Multiple Award Military Munitions Services Performance-Based Acquisition* Contract No. W912DR-15-D-0016. The delivery order was issued by the USACE, Baltimore District, on August 26, 2016.

1.1 Regulatory Framework and Authorization

Pursuant to the Department of Defense (DoD) Manual 4715.20, *Defense Environmental Response Program (DERP) Management* (DoD, 2012), USACE is conducting Military Munitions Response Program (MMRP) activities in accordance with the DERP statute [10 United States Code (USC) 2701 et seq.], the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) (42 USC§9620), Executive Orders 12580 and 13016, and the *National Oil and Hazardous Substances Pollution Contingency Plan* (NCP) [40 Code of Federal Regulations (CFR) Part 300]. The United States Department of Defense (DoD) prepared DOD Instruction (DODI) 4140.62 that establishes policy and assigns responsibilities for the management and disposition of material potentially presenting and explosive hazard (MPPEH), MDEH, and material documented as safe (MDAS). MDEH is synonymous with the term "MEC," which was used in the RI report (CB&I, 2015).

1.2 Purpose

The objective of this FS is to develop, evaluate, and compare remedial action alternatives that will meet the remedial action objectives (RAOs) for the MRS so that DoD can select and propose an appropriate remedy. This FS used the information obtained during the Remedial Investigation (RI) to determine appropriate remedial actions based on the current and anticipated future land uses of the MRS. This FS was developed in accordance with the U.S. Army's *Munitions Response Remedial Investigation/Feasibility Study Guidance* (U.S. Army, 2009) and in accordance with U.S. Environmental Protection Agency (USEPA) guidance documents developed for activities performed under CERCLA, as outlined in the NCP. The guidance documents include *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (USEPA, 1988) and *A Guide to Developing and Document Cost Estimates during the Feasibility Study* (USEPA, 2000).

1.3 MRS Description

The 4.92-acre Fuze and Booster Quarry MRS is located south of Newton Falls Road and north of Fuze and Booster Road at RVAAP. The MRS was a stone and ballast quarry excavated to provide building material for RVAAP. The quarry was used from 1945 until 1949 as an open burn area where sawdust waste generated at Load Lines 6 and 11 was thermally treated. Thereafter, the quarry was used as a landfill that reportedly accepted fuze and booster assemblies, projectiles, residual ash, and sanitary waste. In 1976, the landfill materials, inclusive of the munitions disposed at the MRS, were removed and transferred to either Ramsdell Quarry or one of the other burning grounds at the facility. Around this time the three elongated ponds were constructed at the MRS for use as settling ponds. From 1987 through 1993, spent brine regenerate and sand

filtration backwash water were discharged to the ponds from the facility's potable water treatment system. This discharge was regulated under a National Pollutant Discharge Elimination System (NPDES) permit. The ponds have been inactive since 1993 (e2M, 2007).

The current configuration of the MRS consists of the three elongated ponds situated end to end and separated by earthen berms. The surface water in the ponds is approximately 15 to 20 feet below the surrounding grade, and the depths of the water in the ponds fluctuate depending on the seasons and amount of precipitation. The southern two quarry ponds are filled with water year-round. Water is typically present in the northern pond; however, water levels can vary widely, and sometimes no water is present during very dry periods. The ponds are surrounded by mature hardwood forest, and a gravel road leads up to the western side of the MRS.

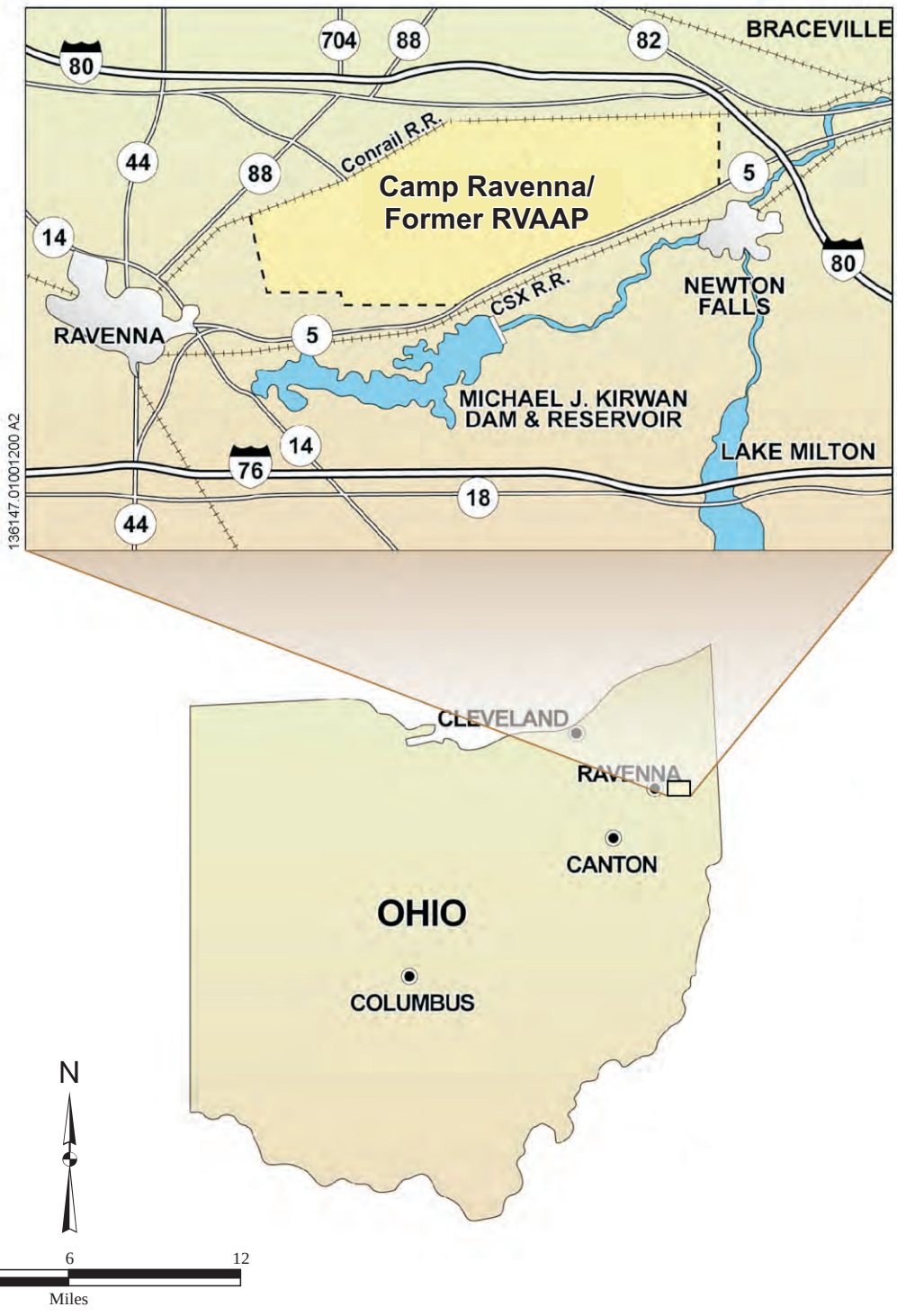
Facility personnel have stated that any type of munitions produced when the facility was in operation may have been destroyed at the MRS. These munitions may have included rockets, bombs, fuzes, detonators, flares, missiles, grenades, landmines, medium- and large-caliber projectiles, explosives, mortars, propellants, practice ordnance, pyrotechnics, and small arms.

1.3.1 Physical Setting and Administrative Control

RVAAP (Federal Facility ID No. OH213820736), now known as the Camp Ravenna Joint Military Training Center (Camp Ravenna), is in northeastern Ohio within Portage and Trumbull Counties and is approximately 3 miles east–northeast of the city of Ravenna. The facility is approximately 11 miles long and 3.5 miles wide. The facility is bounded by the Norfolk Southern Railroad to the north; State Route 5, the Michael J. Kirwan Reservoir, and the CSX System Railroad to the south; State Route 534 to the east; and Garret, McCormick, and Berry Roads to the west. In addition, the facility is surrounded by the communities of Windham, Garrettsville, Newton Falls, Charlestown, and Wayland (Figure 1-1).

Administrative control of the 21,683-acre facility was transferred to the U.S. Property and Fiscal Officer (USP&FO) for Ohio and was subsequently licensed to the Ohio Army National Guard (OHARNG) for use as a training site, Camp Ravenna. The restoration program involves the cleanup of areas associated with operations at RVAAP located across the facility.

The Fuze and Booster MRS is a 4.92-acre parcel located south of Newton Falls Road and north of Fuze and Booster Road (Figure 1-2 and Figure 1-3). The MRS is located on federal property, with administrative accountability assigned to the USP&FO for Ohio. The MRS is jointly managed by the Army National Guard (ARNG) and the OHARNG. Table 1-1 provides an administrative summary of the MRS.



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Source: CB&I

Legend

Camp Ravenna/Former RVAAP

Figure 1-1
Location Map
Camp Ravenna/
Former RVAAP
Portage and Trumbull Counties, Ohio

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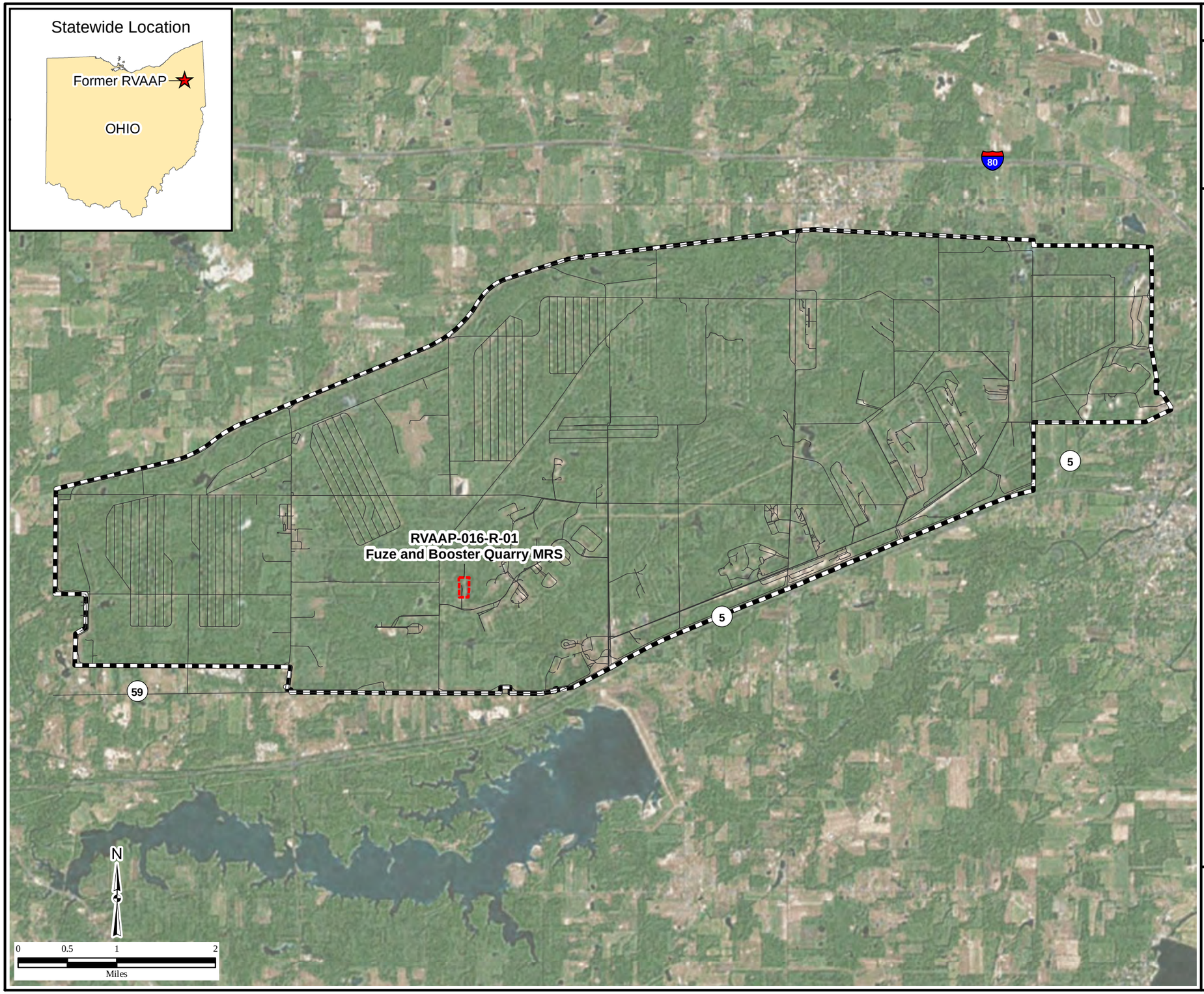
Figure 1-2
MRS Location
Fuze and Booster Quarry
Former RVAAP
Portage and Trumbull Counties, Ohio



Legend

- Road
- MRS
- Installation Boundary

Notes:
MRS=munitions response site
RVAAP=Ravenna Army Ammuntion Plant

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(1-02)FBQ_Site_Map.mxd
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Source: HGL,CB&I, USACE, e²M
ArcGIS Online Imagery

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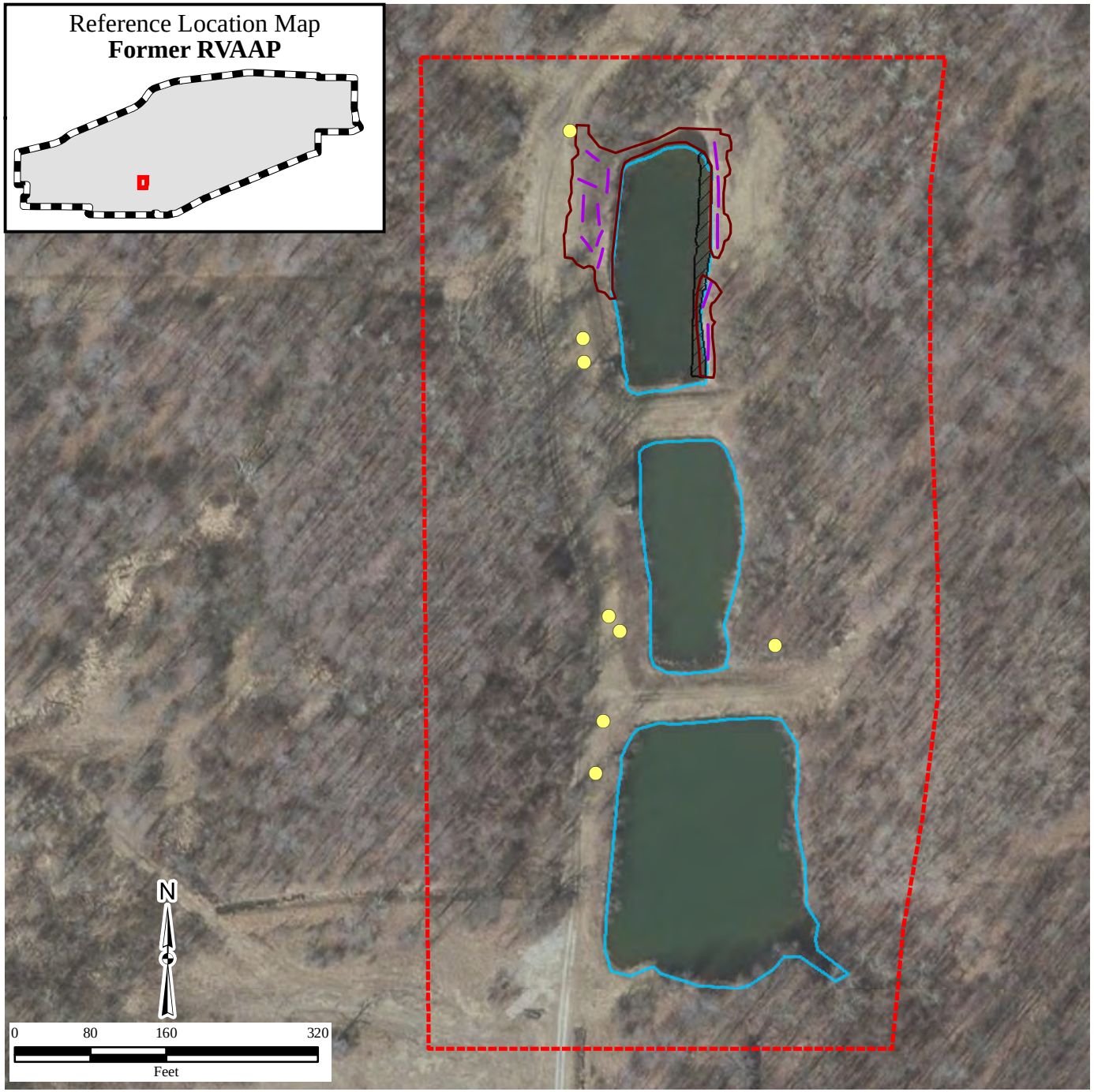

Figure 1-3
RI Intrusive Results
Fuze and Booster
Quarry MRS
Former RVAAP
Portage and Trumbull
Counties, Ohio

Legend

Single Anomaly Results

- MDAS
- Exploratory Trench
- Area of Pond Not Accessible for Diving Operations
- Surface Water
- High Anomaly Density Area
- MRS
- Installation Boundary

Notes:
MDAS=material documented as safe
MRS=munitions response site
RI=Remedial Investigation
RVAAP=Ravenna Army Ammuntion Plant

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2/8/2017 CNL
Source: HGL,CB&I, USACE, e²M
ArcGIS Online Imagery

HGL HydroGeoLogic, Inc

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Table 1-1. Administrative Summary of the Fuze and Booster Quarry MRS

Investigation Area	AEDB-R MRS Number	Area (Acres)	Property Owner	MRS Management Responsibility
Fuze and Booster Quarry MRS	RVAAP-016-R-01	4.92	USP&FO	ARNG/OHARNG

ARNG = Army National Guard.
AEDB-R = Army Environmental Database Restoration Module.
MRS = Munitions Response Site.
OHARNG = Ohio Army National Guard.
USP&FO = U.S. Property and Fiscal Officer.

The institutional analysis presented as Appendix A identifies land use control (LUC) technologies identifies those entities having jurisdiction over Camp Ravenna; and assesses the appropriateness, capability, and willingness of government agencies to implement and maintain LUCs at Camp Ravenna. The institutional analysis determined that ARNG has financial capability to implement LUCs at Camp Ravenna and coordinates the implementation with OHARNG. OHARNG is willing to implement, maintain, and enforce LUCs at this MRS.

1.4 Current and Projected Land Use

The human health risk assessment in the RI was completed prior to the completion of the "Final Technical Memorandum: Land Uses and Revised Risk Assessment Process for the Ravenna Army Ammunition Plant (Risk Assessment Technical Memo) (RVAAP Installation Restoration Program, Portage/Trumbull Counties, Ohio)" (Army National Guard Directorate, 2014). The Risk Assessment Technical Memo defined three Categorical Land Uses and Representative Receptors to be considered during the RI phase of the CERCLA process. The Risk Assessment Technical Memo allowed for exceptions to evaluating these three Land Uses, depending upon their stage of completion for example. These three Land Uses and Representative Receptors are summarized below.

1.) Unrestricted (Residential) Land Use – Resident Receptor (Adult and Child) (formerly called Resident Farmer);

2.) Military Training Land Use – National Guard Trainee; and

3.) Commercial/Industrial Land Use – Industrial Receptor (USEPA Composite Worker).

The Risk Assessment Technical Memo allowed for exceptions to evaluating these three land uses, depending upon their stage of completion, for example. Because the RI was substantially complete by the time the Risk Assessment Technical Memo was finalized, the three Land Uses were not fully evaluated in the RI.

The RI report identified the Military Training Land Use as the most reasonably anticipated land use, and the National Guard Trainee was used as the Representative Receptor. The future land use is still for military training but will also include maintenance, natural resource management, hunting and fishing, and restoration activities (e.g., groundwater monitoring). Neither the hunting and fishing activities nor the National Guard Trainee's exposure scenario equate to full-time work, so neither scenario accounts for the potential of full-time personnel on an MRS. Therefore, when there is a possibility that a full-time occupational exposure may occur on the site, the Commercial/Industrial Land Use using the Industrial Receptor is evaluated. Additionally, the Military Training Land Use requires additional monitoring to ensure no full-time occupational exposure

occurs. For this FS, the Commercial/Industrial Land Use was evaluated using the Industrial Receptor to allow for full-time occupational personnel to work freely on the site.

The exposure scenario for the Industrial Receptor (USEPA's Composite Worker) does not include subsurface exposure. Since the National Guard Trainee's exposure scenario does include subsurface exposure to 4 feet bgs, this value was used to represent the subsurface depth for the Industrial Receptor in this FS. The Ravenna Army Ammunition Plant Facility-Wide Human Health Risk Assessor Manual has detailed descriptions of the exposure scenario and exposure parameters for the National Guard Trainee. The exposure scenario and parameters for the Industrial Receptor can be found at the USEPA's Regional Screening Levels webpage.

1.5 Report Organization

The organization of this FS, including the specific sequence of steps used to develop, screen, and analyze remedial alternatives, is as follows:

- Section 1.0 – Introduction: This section discusses the regulatory framework for and purpose of this FS, describes the MRS property and provides background information regarding it, and summarizes previous investigations.
- Section 2.0 – Project Objectives: This section presents the conceptual site model (CSM) and potential Applicable or Relevant and Appropriate Requirements (ARARs), defines the RAOs, and discusses institutions that may be responsible for implementing LUCs that will be considered in the development and analysis of remedial alternatives.
- Section 3.0 – Identification and Screening of Technologies: This section identifies the range of applicable general response actions and technologies for risk management, and provides an initial screening of such general response actions and technologies to assess whether they should be included as part of a remedial alternative.
- Section 4.0 – Development and Screening of Alternatives: This section presents the various remedial alternatives developed for the Fuze and Booster Quarry MRS, identifies the ARARs potentially associated with each alternative, and provides a preliminary screening of the effectiveness, implementability, and cost of each alternative.
- Section 5.0 – Detailed Analysis of Alternatives: This section presents a detailed evaluation of each remedial alternative developed and retained after the screening process discussed in Section 4.0. The evaluation is based on the nine criteria in the NCP: protection to human health and the environment; compliance with ARARs; long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; implementability; cost; state acceptance; and community acceptance.
- Section 6.0 – Comparative Analysis of Alternatives: This section presents a comparison of the alternatives based on the results of the detailed analysis of alternatives presented in Section 5.0.
- Section 7.0 – References: This section lists pertinent documents cited in this FS report.

2.0 PROJECT OBJECTIVES

This section presents a summary of the CSM and the RAOs for the Fuze and Booster Quarry MRS. Based on the results from the RI, hazards to human health are present from potential exposure to MPPEH at the MRS. Section 2.1 describes the current CSM and details changes made following the RI.

2.1 Conceptual Site Model

The information collected during the RI and the conclusions reached were used to update the CSM and identify actual, potentially complete, or incomplete source-receptor interactions for the MRS for both current and reasonably anticipated future land uses. The CSM (Figure 2-1 and Table 2.1) has three sections: Potential Sources, Interaction, and Receptors for MPPEH, with complete and incomplete exposure pathways identified for each receptor. Each section is discussed below:

- Sources: Sources are those areas where MPPEH has entered (or may enter) the physical system. A source is the location where MPPEH or ordnance is situated or expected to be found.
- Interactions: Hazards from MPPEH arise from direct contact as a result of some human activity. Interactions describe ways that receptors come into contact with a source.
- Receptors: A receptor is an organism (human or ecological) that contacts a chemical or physical agent. The pathway evaluation must consider both current and reasonably anticipated future land use, as receptors are determined on that basis.

The CSM presented in the RI report was revised based on additional information, and details of these changes are presented in the following sections:

- The RI CSM showed incomplete MEC exposure pathways; the FS CSM revision shows a complete pathway for MPPEH (see Section 2.1.1);
- The RI CSM showed MEC presence in the surface and subsurface or submerged in the ponds. The FS CSM revision shows MPPEH present on the surface if exposed by erosion or freeze/thaw cycling and MPPEH present in the subsurface as confirmed during the RI (see Section 2.1.1);
- The RI CSM presented pathways for both the terrestrial portion of the MRS and the ponds. Based on the RI recommendation that the land-based portion only proceed to the FS phase, the FS CSM revision is applicable to the terrestrial areas of the MRS only (see Section 2.1.1); and
- The RI CSM presented the National Guard Trainee and Biota as the applicable receptors. The FS CSM revision includes the Industrial Receptor (see Section 1.4).

Table 2-1. Fuze and Booster Quarry CSM

Description	CSM Finding
Location Profile	
Boundaries	The terrestrial portion of the MRS, not including the ponds, consisting of 2.5 acres as shown in Figure 1.3.
Structures	No structures and no paved roads are located within the MRS.
Utilities	No utilities are located within the MRS.
Security	Access to Camp Ravenna is controlled; however, access to the MRS is unrestricted.
Land Use and Receptors	
Current Land Use	Maintenance and natural resource management activities
Potential Future Land Use	Potential military training and hunting or fishing
Human Receptors	Industrial Receptor
Wetlands	Seasonal wetlands have been identified in the shallow areas of the quarry ponds through planning-level surveys; however, a jurisdictional delineation has not been conducted at the MRS.
Ecological Receptors	None
Cultural Resources	A cultural resources survey has not been conducted at this MRS.

2.1.1 MPPEH Exposure Pathway Analysis

An exposure pathway is the course a chemical or physical agent takes from a source to a receptor. Each potential MPPEH pathway includes a source, interaction (access and activity), and a receptor. A pathway is considered complete when a source is known to exist and when receptors have access to the MRS while engaging in some activity which results in contact with the source. A pathway is considered potentially complete when a source has not been confirmed, but is suspected to exist and when receptors have access to the MRS while engaging in some activity which results in contact with the source. Lastly, an incomplete pathway is any case where one of the four components (source, activity, access, or receptors) is missing from the MRS. As summarized in Figure 2-1 and Table 2.1, complete pathways exist for MPPEH for terrestrial portions of the Fuze and Booster Quarry MRS, specifically in the surface and subsurface. Section 2.1.1.1 describes the confirmed presence of subsurface MPPEH and Section 2.1.1.3 describes the potential for MPPEH to reach the ground surface through erosion and freeze-thaw cycling. These elements are the basis for the complete pathways in the surface and subsurface.

The RI CSM showed incomplete MEC exposure pathways and the FS CSM has been revised (Figure 2-1) to show a complete pathway for MPPEH. The RI addressed MEC as the source of explosive hazards; this FS presents MPPEH as the source of explosive hazards because MPPEH includes both MDEH (MEC, which is explosively hazardous) and MDAS (which is not explosively hazardous, but can indicate the potential presence of MDEH). MDEH is synonymous with the term "MEC," which was used in the RI report. No MEC was identified during the RI, only MDAS. Owing to the presence of MDAS, it was recommended that the MRS proceed to the FS stage (Section 2.2) (CB&I, 2015).

The RI CSM showed that MDEH was potentially present in the surface and subsurface or submerged in the ponds. Both pathways were shown as incomplete because no MDEH was found during the RI. The FS CSM revision shows that exposure to MPPEH is a complete pathway for MPPEH on the surface if exposed by erosion or freeze/thaw cycling. The RI sections covering the topography, geology and soils, and surface water features for the MRS indicate that erosion may occur based on the soil types and the surface water flow into the ponds (CB&I, 2015). The FS CSM revision shows that MPPEH is present in the subsurface at the MRS as was confirmed during the RI (see Section 2.2) (CB&I, 2015).

2.1.1.1 Source

An RI was completed at the Fuze and Booster Quarry MRS in 2015 to determine the nature and extent of MPPEH and munitions constituents (MC) and to identify the associated hazards and risks posed to likely human and ecological receptors. No MDEH was discovered during the RI. Approximately 74.5 pounds of material documented as safe (MDAS) were encountered between 2 inches below ground surface (bgs) and 14 inches bgs within eight targets following the digital geophysical mapping (DGM) survey (Figure 1-3). MDAS was identified at isolated locations along slopes on the western sides of the two ponds. MDAS included parts from the following munitions:

- 20mm M75 series armor-piercing tracers,
- 75mm MK1 series high-explosive projectiles,
- 155mm MK1 high-explosive projectiles, and
- Fuze and fragments associated with unknown munitions types.

In addition, thirteen trenches were dug within areas with high anomaly densities along the banks of the northern pond. Most of the trenches were 20 feet in length. No MPPEH were recovered from the trenches.

Divers performed an underwater investigation in the three ponds as part of the RI. Diving operations were not performed over a small 0.08-acre area near the eastern shore of the northern pond where the water depth is approximately 1 to 2 feet and heavily vegetation. No MPPEH was found during this underwater investigation.

Based on the RI underwater investigation results that did not recover MPPEH, only the terrestrial portion of the MRS is evaluated in this FS, including the pond banks. The southern two quarry ponds are filled with water year-round. Water is typically present in the northern pond; however, water levels can vary widely, and sometimes no water is present during very dry periods. The terrestrial boundary for this FS is based upon a very dry period and assumes 7 feet of water in the southern two quarry ponds and no water present in the northern pond. Seasonal wetland areas are found in the shallow areas of the quarry ponds (SAIC and SpecPro, 2005).

The RI concluded that the Fuze and Booster Quarry MRS should move forward to the FS phase to assess response action alternatives for MPPEH potentially present in the terrestrial areas only. The RI identified MPPEH within the terrestrial portions only of the MRS including the pond banks. Although no MDEH was found during the RI, the presence of munitions at the MRS is confirmed and the potential remains for MPPEH to be present on the surface and in the subsurface of the MRS.

2.1.1.2 Receptors

A receptor for the CSM is any human who comes into physical contact with a potential explosive hazard. The future land use for the Fuze and Booster Quarry MRS is Commercial/Industrial Land Use, and the human receptor with the greatest opportunity for exposure to an explosive hazard is the Industrial Receptor. As established in Section 1.4, the Industrial Receptor represents a full-time occupational receptor at the MRS, and the Commercial/Industrial Land Use includes activities consistent with full-time employees or career military personnel who are expected to work daily at Camp Ravenna. The maximum exposure depth for the Industrial Receptor is 4 feet bgs, which is below the maximum depth that MPPEH was found during the RI field work (8 inches bgs). Section 1.4 provides details on current and projected land use for this MRS.

2.1.1.3 Interaction

Interaction describes ways that receptors contact a source, and includes both access and activity considerations. Activity describes ways that receptors come into contact with a source. Access describes the degree to which MPPEH is available to potential receptors. A receptor may contact MPPEH that is on the surface by walking through the MRS and treading on MPPEH unintentionally. A receptor may contact MPPEH in the subsurface when performing intrusive activities.

Current activities at the Fuze and Booster Quarry MRS include maintenance, natural resource management activities such as walking, and restoration activities (e.g., monitoring of existing groundwater wells). Current activities conducted at the MRS are not intrusive; however, based on potential military training the National Guard Trainee's exposure scenario does include subsurface exposure to 4 feet bgs. This value was used to represent the subsurface depth for the Industrial Receptor in this FS. Future land use for this MRS is expected to include the current activities and potentially military training activities. No construction projects requiring intrusive activities are planned for the MRS. As stated in Section 1.4, the Industrial Receptor is the Representative Receptor for this MRS, with a subsurface exposure depth defined as 4 feet bgs. Once on the MRS, receptors would have access to any potential MPPEH on the ground surface.

Based on the soil types and climate conditions at the MRS, any MPPEH within 3 feet of the ground surface is considered as being susceptible to freeze-thaw cycling, which in addition to erosion may ultimately result in subsurface MPPEH reaching the ground surface (CB&I, 2015).

2.1.1.4 MPPEH Exposure Conclusions

The RI confirmed that munitions were present at the MRS; however, no direct evidence of an explosive hazard exists. Therefore, there is a low probability for MDEH to be present at the MRS based on the type of MPPEH (verified as MDAS) discovered during the RI and the historical munitions-related activities conducted at the MRS. The surface and the subsurface pathways for MPPEH are considered complete for the Industrial Receptor.

2.1.2 MC Exposure Pathway Analysis

The RI confirmed that no known or suspected MC risk exists at the MRS; therefore, there is not a complete MC exposure pathway for receptors.

2.2 Problem Identification

Although no MDEH was found during the RI, the use or introduction of munitions at the MRS is confirmed. Based on the historical use of the MRS as a former landfill that reportedly accepted munitions and MPPEH found on the during the RI field work, the potential remains for residual MPPEH to be present on the surface and in the subsurface at the MRS in the terrestrial portion only. The presence of MPPEH at the MRS represents a potential exposure risk to the Industrial Receptor that has a maximum exposure depth of 4 feet bgs.

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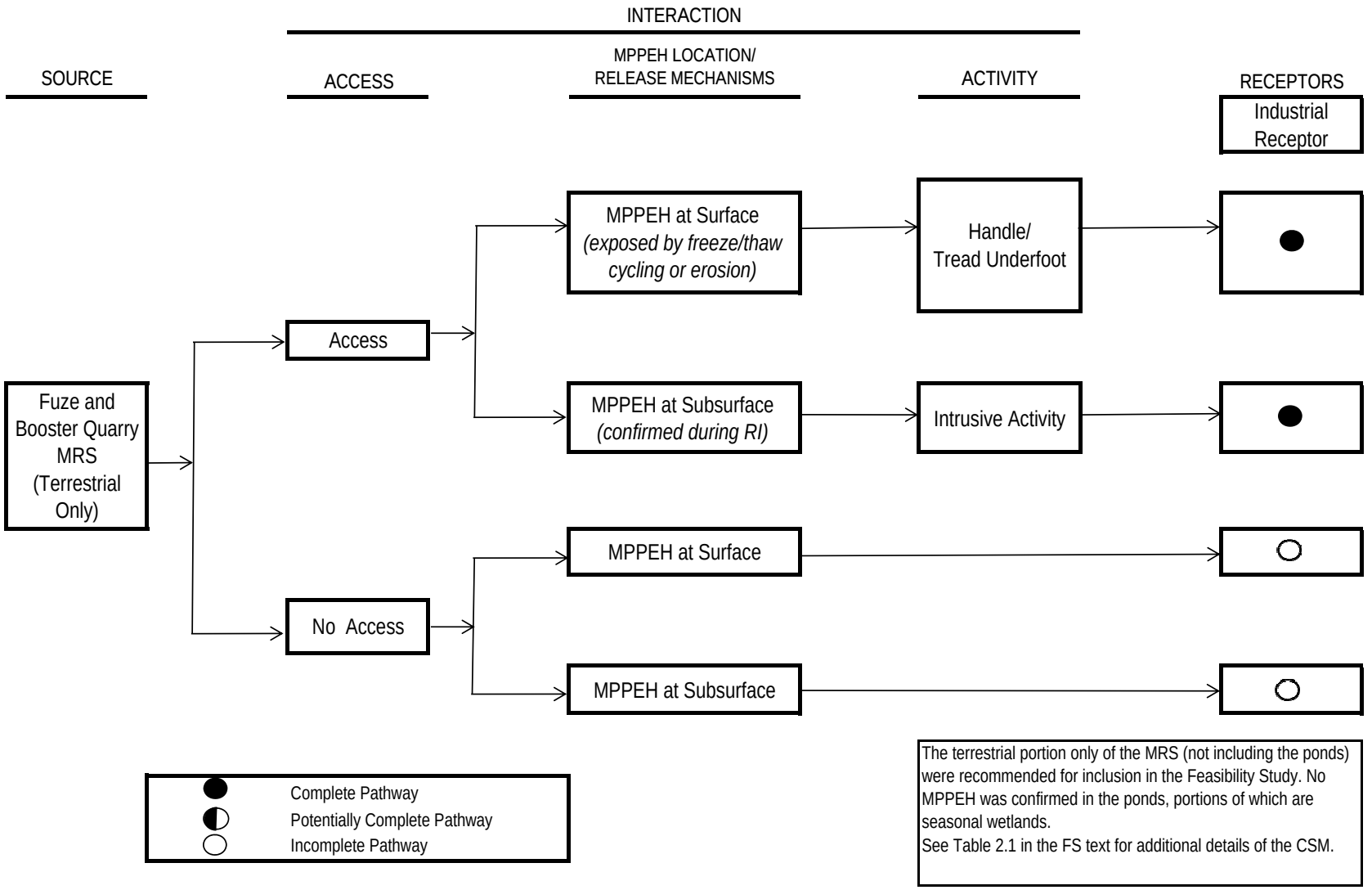
FIGURE 2-1 MPPEH CONCEPTUAL SITE MODEL
RVAAP-016-R-01 FUZE AND BOOSTER QUARRY MRS



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2.3 Preliminary Identification of Applicable or Relevant and Appropriate Requirements and "To Be Considered" Information

Under Section 121 (d)(2)(A) of CERCLA, remedial actions must meet a level and standard of control that attain standards, requirements, limitations, or criteria that are "applicable or relevant and appropriate" under the circumstances of the release. These standards, requirements, limitations or criteria are derived from federal and state laws and are known as ARARs. Federal, state, or local permits are not necessary for removal or remedial actions implemented under a CERCLA remedial action, but ARARs must be met.

The NCP (40 CFR 300.5) defines "applicable requirements" as follows:

> …those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site.

The NCP (40 CFR 300.5) defines "relevant and appropriate requirements" as

> those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal or state environmental or facility siting laws that, while not applicable to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site.

In addition to legally binding laws and regulations, many federal and state environmental public health programs also develop criteria, advisories, guidance, and proposed standards that are not legally binding but may provide useful information or recommended procedures. These to be considered (TBC) requirements are not promulgated and, thus, are not potential ARARs.

State requirements identified in a timely manner that are more stringent than corresponding federal requirements may be applicable or relevant and appropriate.

USEPA classifies ARARs as chemical-, action-, and location-specific to provide guidance for identifying and complying with ARARs (USEPA 1988a).All ARARs must meet the following criteria:

- Are limited to promulgated requirements;
- Are environmental or facility siting laws;
- Are substantive requirements; and
- Pertain to the circumstances at the MRS.

2.3.1 Chemical-Specific ARARs and TBCs

Chemical-specific ARARs are health- and risk-based numerical values and methodologies that, when applied to MRS-specific conditions, result in the establishment of numerical values. These values and methodologies (such as promulgated standards and risk assessments, respectively) establish acceptable concentrations of a chemical contaminant that may remain in the environment. Chemical-specific TBCs may be used in the absence of chemical-specific ARARs or where chemical-specific ARARs are not sufficiently protective to develop remediation goals. As discussed in Section 1.5.5 and 2.1.2, there is no known or suspected MC risk at the MRS. Therefore, there are no chemical-specific ARARs or TBCs identified for the MRS.

2.3.2 Location-Specific ARARs

Location requirements include those established for potential remedial activities conducted within wetlands or within a floodplain area, or with respect to threatened and endangered species. Generally, for wetlands and floodplains, rules require that alternatives to remedial activity within the sensitive area be pursued, and if that is not feasible, then adverse effects from any actions taken within the sensitive area be mitigated to the extent possible. The Endangered Species Act (ESA) exists to protect the habitat or body of flora and fauna that are threatened or endangered.

Under CERCLA Section 121(d), relevance and appropriateness are related to the circumstances presented by the release of hazardous substances, with the goal of attaining a degree of cleanup and control of further releases that ensures the protection of human health and the environment. Location requirements for wetlands and floodplains, as well as requirements of the ESA, do not relate to the degree of cleanup as much as they relate to protecting sensitive areas and threatened and endangered species from effects of remedial activities. They do not further the degree of cleanup in the sense of protecting human health or the environment from the effects of harmful substances or hazardous items. The purpose of the location rule requirements does not address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited as an ARAR; that is, the rule requirements are not sufficiently relevant and appropriate under CERCLA Section 121(d) as related to the circumstances of the release, degree of cleanup, or protectiveness of remedial action, to include these requirements as ARARs.

Facility-specific guidelines related to the protection of wetlands and threatened or endangered species would be followed during remedial activity. Seasonal wetlands have been identified through planning-level surveys in the shallow areas of the Fuze and Booster Quarry MRS quarry ponds; however, a jurisdictional delineation has not been conducted. The facility *Integrated Natural Resources Management Plan* (INRMP) (OHARNG, 2014) wetland and floodplain guidelines state that Camp Ravenna will minimize the destruction, loss, or degradation of wetlands. Therefore, it is anticipated that any potential impacts to the seasonal wetlands during a response action would be minimal.

There are no federal-listed species or critical habitats at the Fuze and Booster Quarry MRS based on the facility INRMP (OHARNG, 2014). Although biological inventories have not been completed specifically for the MRS and no confirmed sightings of state-listed species have been reported, there is potential for state-listed or rare species to be present within the MRS boundary. The Northern long-eared bat is a federally threatened species that was found at Camp Ravenna and is now listed for the facility. There are vegetation cutting restrictions in place for Camp Ravenna during the Northern long-eared bat summer roosting season, which is between April 1 and September 30. The primary restriction is that vegetation/trees greater than 3 inches in diameter may not be cut during this period.

Any action taken by the Federal Government must be conducted in accordance with requirements established under the National Environmental Policy Act (NEPA), ESA, National Historic Preservation Act, and federal and state wetlands and floodplains construction and placement of material considerations, even though these laws and rules do not establish standards, requirements, limitations, or criteria relating to the degree of cleanup for contaminants remaining on-site at the close of the response actions. The requirements discussed above are not ARARs. There are no location-specific ARARs or TBCs identified for the MRS.

2.3.3 Action-Specific ARARs

Action-specific ARARs are technology- or activity-based requirements or limitations on actions to be taken with respect to a remedial action. These requirements are triggered by the particular remedial activities selected to accomplish a remedy. Alternatives 3 and 4 require vegetation clearance and disturbance of approximately 2.5 acres. Rules 1501:15-1-01 to 1501:15-1-06 of the Ohio Administrative Code (OAC) establish state standards (which have more specificity and thus more stringency than the federal requirements) to achieve a level of management and conservation practices that will control wind or water erosion of the soil and minimize the degradation of water resources by soil and sediment in conjunction with land grading, excavating, filling, or other soil-disturbing activities. These rules apply to development areas involving new or relocated projects such as highways, underground cables, pipelines or railroads; or other state and federal agency projects required to control sediment pollution pursuant to any applicable federal or state statutory or administrative authority. As such, they are relevant and appropriate to this action. Rules 1501:15-1-03 and 1501:15-1-05 of the OAC do not apply to areas of less than 5 acres. Therefore, only the standards described in OAC 1501:15-1-04 are relevant and appropriate to the remedial action. ARARs for the Fuze and Booster Quarry MRS are presented in Table 2-2 below.

Table 2-2. Fuze and Booster ARARs

Requirement	Citation(s)	Description	Applicable	Relevant and Appropriate	Comments
Chemical-Specific ARARs and TBCs					
None - MC not identified					
Location-Specific ARARs and TBCs					
None					
Action-Specific ARARs					
Erosion and Sediment Control	OAC 1501:15-1-04 Standards	These rules require that sediment and erosion controls be employed in areas of denudation and land disturbance, and describe management and conservation practices that will control wind or water erosion of the soil and minimize the degradation of water resources by soil and sediment.	No. The area does not exceed the minimum size (5 acres for soil and erosion control, 1 acre for storm waterpermit) for land grading, excavation, filling or other soil disturbance activities. In addition, land is not being developed for non-farm commercial, industrial, residential, or other non-farm purposes.	Yes. Excavation and removal of MPPEH does disturb the land surface that may contribute to erosion and sedimentation.	Relevant to Alternatives 3 and 4.

2.4 Remedial Action Objectives

RAOs are developed based on the CSM to determine the effectiveness of the remedial action on the MRS, and they are focused on limiting or removing exposure pathways for MPPEH (U.S. Army, 2009). RAOs specify the contaminants and media of concern, potential exposure pathways, and remediation goals (40 CFR 300.430(e)(2)(i)). The RAOs for the MRS address the overall goals of managing the residual explosive hazards and protecting human receptors from these hazards.

This FS addresses the potential for explosive hazards from residual MPPEH remaining at the Fuze and Booster Quarry MRS. The media of concern is surface soil between ground surface to 4 feet bgs, the maximum exposure depth for the Industrial Receptor. The maximum depth of recovered MDAS during the RI was 14 inches bgs, which falls within maximum receptor exposure depth of 4 feet bgs. Trenches were investigated to depths up to 10 to 12 feet, providing confidence in the RI MDAS depth findings at this MRS.

Based on the Industrial Receptor maximum exposure depth and supported by the RI MDAS maximum depth recoveries, the following RAOs were developed for the Fuze and Booster Quarry MRS:

- Reduce the unacceptable hazard of MPPEH on the surface such that the likelihood of an Industrial Receptor encountering an explosive hazard via direct contact is negligible.
- Reduce the unacceptable hazard of MPPEH to a depth of 4 feet bgs such that the likelihood of an Industrial Receptor encountering an explosive hazard via direct contact is negligible.

The technologies and process options developed to support general response actions (GRAs) to attain the RAOs are presented in Section 3.0 and are screened in Section 4.0.

2.5 Summary of Institutional Analysis

The Facility-Wide Institutional Analysis for the Former Ravenna Army Ammunition Plant, hereafter referred to as the IA, was prepared to support the development and initial screening of LUCs. LUCs protect property owners, and other workers or personnel, from potential hazards by warning them of their existence and/or limiting access to, or use of, the MRS. LUCs can include legal mechanisms, engineering controls, and educational controls. However, the effectiveness of LUCs depends on the support, involvement, and willingness of local agencies, stakeholders, and landowners to enforce and maintain them. Further, not all LUCs are appropriate for implementation at Camp Ravenna and the LUCs that were retained for evaluation in the screening process following the IA are presented in Section 3.2.2. The IA is presented in Appendix A.

The institutions identified and analyzed in the IA that have jurisdiction or authority at the MRS include the USP&FO, OHARNG/Camp Ravenna, ARNG, the Ohio EPA, and USACE. The IA establishes that the Army National Guard has the financial capability to establish, implement, and maintain LUCs at the MRS. The ARNG has the financial capability to implement LUCs and coordinates that implementation with OHARNG. The OHARNG has the willingness and authority to implement LUCs at Camp Ravenna.

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3.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

Development of remedial alternatives begins with identifying applicable remedial technologies. This section identifies and screens remedial technologies that can address MPPEH at the Fuze and Booster Quarry MRS in accordance with the U.S. Army MMRP RI/FS guidance (U.S. Army, 2009), USEPA guidance (USEPA, 1988), and the NCP (USEPA, 1990).

The primary objective of identifying, screening, and evaluating potentially applicable technologies and process options for the Fuze and Booster Quarry MRS is to identify those than can be developed into remediation alternatives. The USEPA guidance for conducting RIs/FSs under CERCLA (USEPA, 1988a) establishes a structure for this process. A series of steps is used to reduce the potential remedial options to a smaller group of viable ones, from which remedial alternatives are developed. This series of steps is as follows:

- Identify the MRS area and volume of soil potentially containing MPPEH based on the RAO;
- Identify GRAs to achieve the RAO; and
- Identify technologies and process options based on the GRA options, which are then screened based on effectiveness, implementability, and cost.

3.1 General Response Actions

GRAs are those actions that will achieve the RAOs and may include detection, removal, and disposal (by demolition) of MPPEH; LUCs; or combinations of these actions. Under CERCLA, evaluation of a No Action alternative is required, pursuant to the NCP (40 CFR 300.430 et seq.), to provide a baseline for the other remedial technologies and alternatives. No action refers to an MRS remedy under which no active remediation or enforceable LUCs are implemented. The DERP manual (DoD, 2012) requires the DoD Component to include at least three alternatives, including no action, an action to remediate to UU/UE, and an action to remediate an MRS to a protective condition that uses LUCs. The following GRAs have been identified and considered for the Fuze and Booster Quarry MRS:

- No Action: As stated above, the No Action alternative provides a baseline response for comparison to other remedial response actions.
- Land Use Controls: This GRA includes physical, legal, and administrative mechanisms used to mitigate the explosive hazards associated with the MPPEH present on the MRS. The development and screening of LUCs processes for this MRS is presented in the institutional analysis presented in Appendix A. This FS includes LUCs retained from the institutional analysis.
- MPPEH Detection: Detection technologies involve locating hazards (e.g., MPPEH) in the environment. Detection is generally used in conjunction with removal and disposal (by demolition) to meet RAOs, but can also be used to identify areas for LUCs. Detection process options examined were DGM, advanced classification, and analog identification of anomalies.
- MPPEH Removal: This GRA includes physical removal of MPPEH to reduce its potential impact on potential receptors and the environment. Removal process options examined included, but were not limited to, hand excavation, mechanical excavation, and mechanical excavation of soils followed by sifting.

- MDEH Disposal: This GRA implements physical measures to reduce the MPPEH hazard, such as MDEH disposal via intentional detonation/demolition.
- Containment: This GRA includes technologies that reduce the mobility or accessibility of MPPEH. These types of technologies do not address the hazardous nature or quantity of MPPEH.

Except for the No Action alternative, the GRAs identified above may be combined to develop remedial action alternatives for the Fuze and Booster Quarry MRS. Section 3.2 below provides further discussion of GRAs and the technologies that comprise them.

3.2 Remedial Technologies and Process Options

This section documents the identification and screening of remedial technology types and process options applicable to each GRA. Technology types and process options retained from the identification and screening step will be used to formulate remedial alternatives discussed in subsequent sections of the FS. Remedial alternatives are developed by assembling combinations of applicable technologies and other unit processes into a sequence of actions which address the specific media to which they would be applied and the RAOs that were developed for the MRS. Accordingly, the identification and screening of remedial technology types and process options is a necessary and important first step in the development of alternatives. The matrix of process options developed in this section is not intended to comprise all processes that exist; it is intended as a broad spectrum of potentially applicable process options considering MRS conditions and the CSM. Additionally, a Five-Year Review process conducted by the OHARNG is required for any alternative that would leave residual hazards at the MRS.

The evaluation of remedial technology types and process options is a two-step process. The first step is an initial screening of technologies and process options. This is generally done on the basis of technical implementability in order to eliminate process options or entire technology types that would clearly be ineffective or unworkable considering MRS conditions and MPPEH hazards. The types and concentrations of the MPPEH can also influence the selection of suitable technologies. Typically, this screening step is MRS-specific; however, other factors may also need to be considered. Figure 3-1 presents preliminary identification and screening of remedial technologies and process options. Those that are not technically feasible at the MRS are immediately screened out of further consideration.

The second step in this process is to evaluate the process options considered to be technically implementable in greater detail in order to select the representative process for each technology type. The evaluation of process options is generally based on the three criteria of: 1) effectiveness, 2) implementability; and 3) cost. Although these are the same criteria used to screen remedial alternatives prior to detailed analysis, at this stage these criteria are applied only to technologies and process options and not to MRS-wide alternatives. In addition, the evaluation of process options focuses more on assessing effectiveness and less on implementability and cost. The evaluation measurements for the three criteria are presented in further detail below:

- Effectiveness: The technologies processes that are identified will be evaluated further on their effectiveness relative to the other processes within the same technology types. The evaluation for effectiveness will focus on: 1) the potential effectiveness of the process options in handling the residual MPPEH and meeting the RAOs; 2) the potential effects on human health and the environment during implementation; and 3) how proven and reliable the process option is with respect to addressing residual MPPEH and the conditions at the MRS (USEPA, 1988).

- **Implementability:** The ability of the technology to be implemented at the MRS. Implementability consists of both technical and administrative feasibility. Technical feasibility considerations may include the availability of necessary services, equipment, and skilled workers to implement a remedial technology. Administrative implementability considerations include the ability to obtain necessary permits for offsite actions as well as the availability of treatment, storage, and disposal services (including capacity), and the availability of necessary equipment and skilled workers to implement the technology (USEPA, 1988).
- **Cost:** The relative cost with respect to both capital and operation and maintenance (O&M) requirements. The analysis and costs are estimated on the basis of engineering judgment. An option is evaluated as to whether its costs are high, low, or moderate relative to other options within the same technology type. If two options are determined to provide equal benefits with regards to effectiveness and implementability, the higher cost option is eliminated from further analysis (USEPA, 1988).

Figure 3-2 further screens the identified technologies on the three criteria. Technologies and process options that are retained are incorporated in alternatives developed in Section 4.0 (Figure 3-3).

3.2.1 No Action

There are no remedial technologies or process options for the No Action GRA. This GRA is retained for detailed evaluation as required by the NCP.

3.2.2 Land Use Controls

Under the MMRP, LUCs are used in CERCLA remedies to prevent or control exposures of potential receptors to explosive hazards that may remain in place at the site "…to assure continued effectiveness of the response action" (40 CFR 300.430 [e][3][ii]). LUCs consist of various legal mechanisms and engineering and educational controls that minimize the potential for risk to human receptors at an MRS with known MPPEH. Instead of direct elimination of MPPEH, LUCs rely on behavior modification and/or access control strategies to reduce or eliminate risk. The development and screening of LUCs for this MRS is presented in the IA (Appendix A). This section presents LUC remedial technologies and process options that were retained during the screening process and are retained from the IA.

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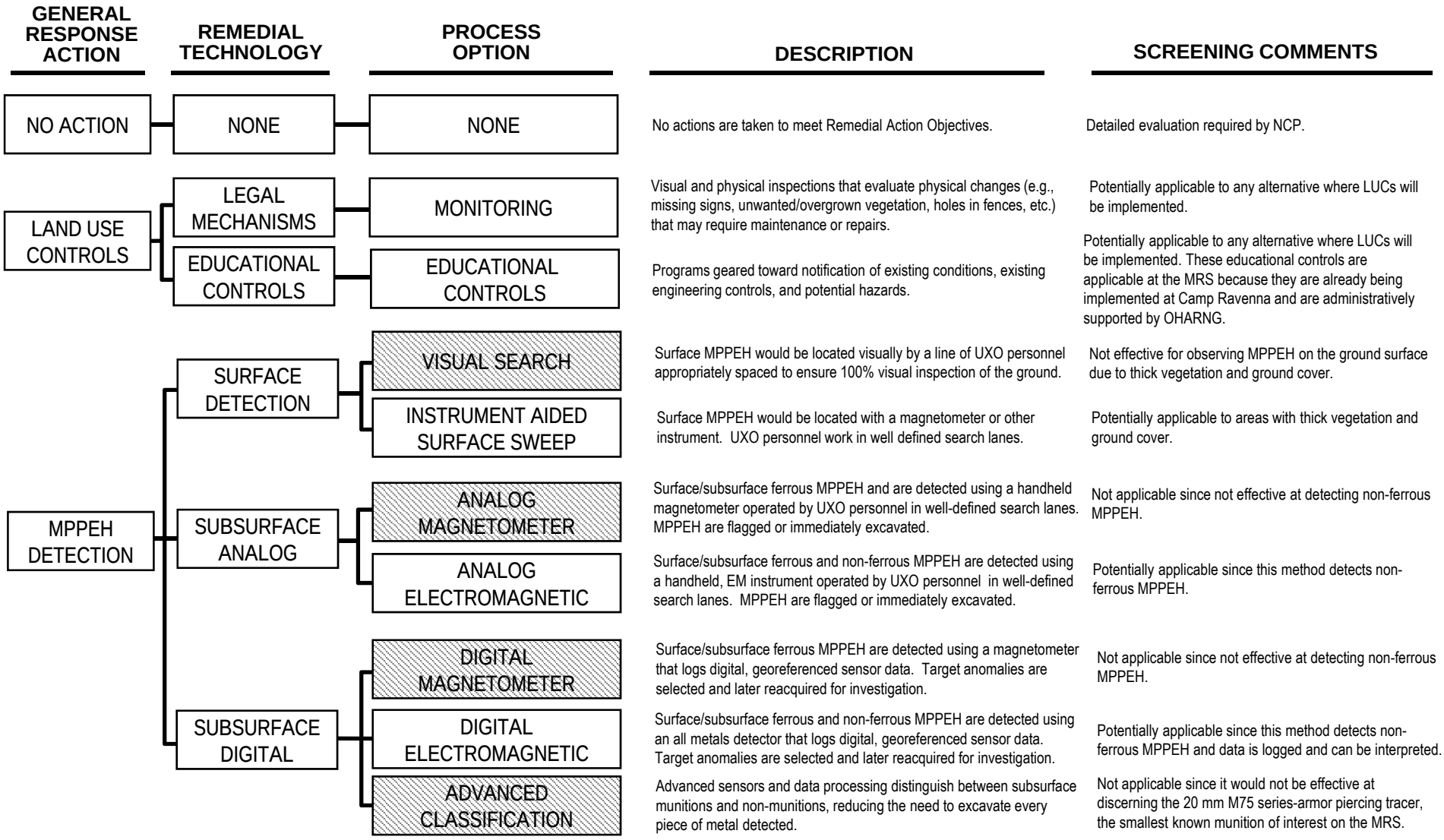
FIGURE 3-1. PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS
RVAAP-016-R-01 FUZE AND BOOSTER QUARRY MRS



Eliminated from further consideration *Retained for further consideration*

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FIGURE 3-1. PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS
RVAAP-016-R-01 FUZE AND BOOSTER QUARRY MRS

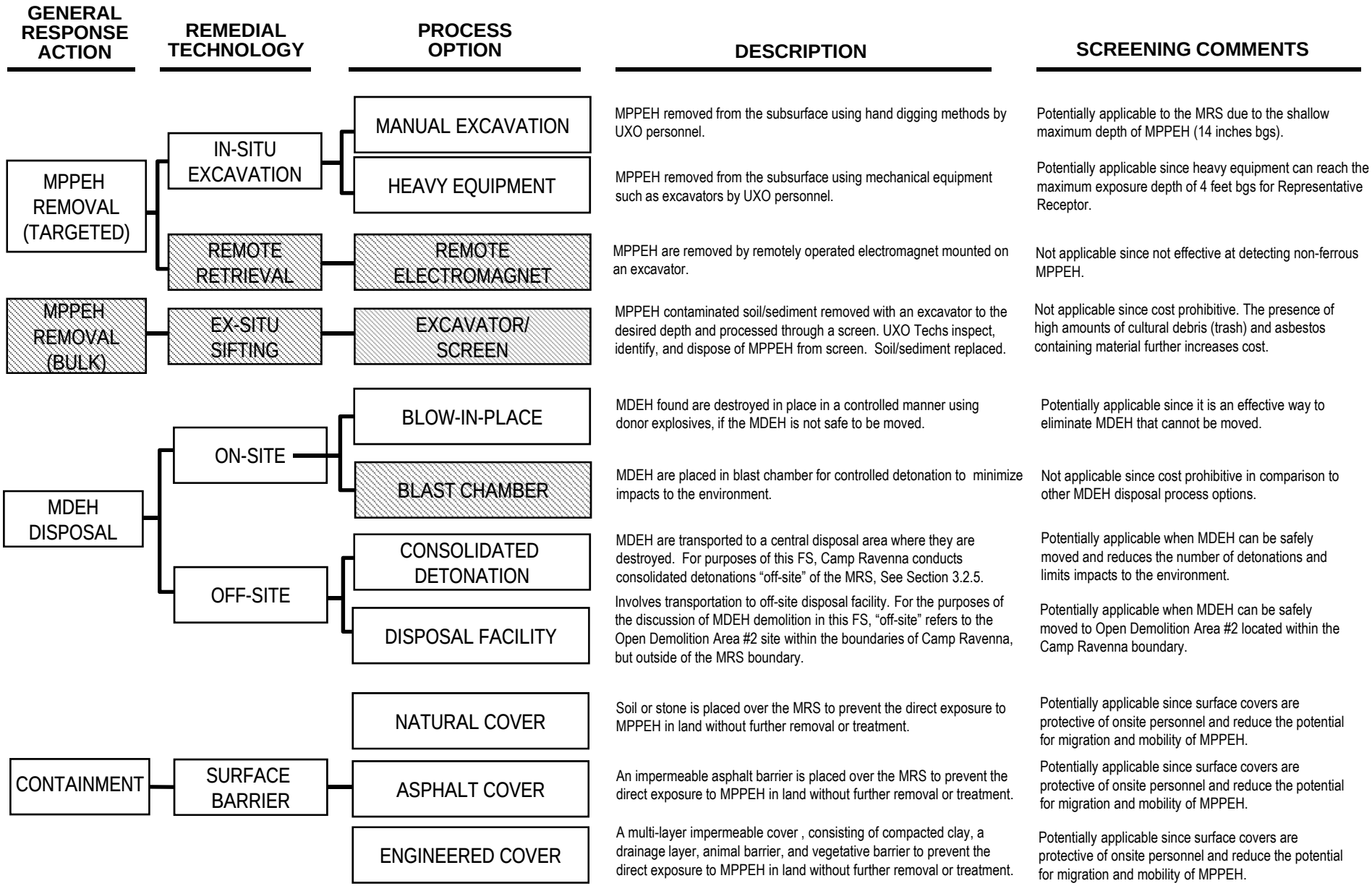

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FIGURE 3-2. EVALUATION OF PROCESS OPTIONS
RVAAP-016-R-01 FUZE AND BOOSTER QUARRY MRS

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST
NO ACTION	NONE	NONE	Does not mitigate potential explosive hazards	Technical feasibility does not apply as no actions are required; however, not administratively feasible as no reduction in explosive hazards occurs.	Capital: None O&M: None
LAND USE CONTROLS	LEGAL MECHANISMS	MONITORING	Effective at evaluating current conditions at the MRS but does not reduce contamination.	Exposure hours monitoring is not administratively feasible for trainees accessing the MRS; however, monitoring is administratively feasible for any LUCs implemented for the MRS.	Capital: Med O&M: Low
	EDUCATIONAL CONTROLS	EDUCATIONAL CONTROLS	Effective in training authorized personnel entering an MRS to recognize and avoid MPPEH hazards. This measure is only effective for authorized personnel.	Readily implemented but requires experienced personnel to provide training. This is administratively feasible as OHARNG already conducts training as an interim control.	Capital: Low O&M: Low
MPPEH DETECTION	SURFACE DETECTION	INSTRUMENT AIDED SURFACE SWEEP	Effective at removing surface MPPEH. Subsurface MPPEH will remain	Readily implemented in areas with thick vegetation and ground cover and is administratively feasible.	Capital: Low O&M: None
	SUBSURFACE ANALOG	ANALOG ELECTROMAGNETIC	Effective at detecting ferrous and non-ferrous MPPEH within 2 to 3 feet. Sensitivity decreases with depth and decrease in object size.	Readily implemented and is administratively feasible, but time consuming since this method detects all metal anomalies that will require investigation.	Capital: High O&M: None
	SUBSURFACE DIGITAL	DIGITAL ELECTROMAGNETIC	Effective at detecting ferrous and non-ferrous MPPEH within 4 feet or more. Sensitivity decreases with depth and decrease in object size.	Readily implemented and preferred method for MPPEH detection due to ability to collect, analyze, and process data for targeted MPPEH removal and is administratively feasible.	Capital: Med O&M: None
MPPEH REMOVAL (TARGETED)	IN-SITU EXCAVATION	MANUAL EXCAVATION	Effective at reaching shallow MPPEH within 2 to 3 feet below ground surface.	Readily implemented at areas where MPPEH expected shallow depths (i.e., less than 1 foot bgs) and is administratively feasible.	Capital: Low O&M: None
		HEAVY EQUIPMENT	Effective at reaching exposure depth of 4 feet bgs for Representative Receptor.	Readily implemented and is administratively feasible, but is disruptive to the environment where MPPEH is only expected at shallow depths (i.e., less than 1 foot bgs).	Capital: High O&M: None
MDEH DISPOSAL	ON-SITE	BLOW-IN-PLACE	Effective at eliminating MDEH from the MRS.	Readily implemented and is administratively feasible. Camp Ravenna currently coordinates MPPEH requiring blow-in-place with Explosive Ordnance Disposal.	Capital: Low O&M: None
	OFF-SITE	CONSOLIDATED DETONATION	Effective at eliminating MDEH from the MRS	Readily implemented and is administratively feasible. Camp Ravenna currently conducts consolidated detonations at Open Demolition Area #2.	Capital: Low O&M: None

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FIGURE 3-2. EVALUATION OF PROCESS OPTIONS
RVAAP-016-R-01 FUZE AND BOOSTER QUARRY MRS

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST
CONTAINMENT	SURFACE BARRIER	NATURAL COVER	Effective at direct exposure to MPPEH and reduces the potential for migration and mobility of MPPEH. Does not remove the MPPEH.	Readily implemented but not administratively feasible as it requires routine inspections. Impact to the environment is not acceptable to Camp Ravenna.	Capital: Low O&M: High
		ASPHALT COVER	Effective at direct exposure to MPPEH and reduces the potential for migration and mobility of MPPEH. Does not remove the MPPEH.	Readily implemented but not administratively feasible as it is not consistent with surrounding uses at Camp Ravenna.	Capital: Mod O&M: Mod
		ENGINEERED COVER	Effective at direct exposure to MPPEH and reduces the potential for migration and mobility of MPPEH. Does not remove the MPPEH.	Readily implemented but requires routine inspections. Not administratively feasible as the impact to the environment is not acceptable to Camp Ravenna.	Capital: High O&M: High

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Monitoring

Monitoring at the MRS is a legal mechanism process option that would include visual and physical inspections of the conditions at the MRS to determine the need for repairs and/or replacement of any engineering controls. Examples of monitoring activities include UXO-qualified escorts periodically conducting enhanced visual surveys. These activities ensure early identification and response for any MDEH. The process option meets the RAOs since it would be effective at reducing the unacceptable potential hazard of MPPEH at the MRS and would be protective of human health by ensuring that effectiveness of the selected remedial alternative is maintained. This process option is technically feasible to implement since materials and services to conduct monitoring are easily obtainable but it requires experienced and readily available personnel to make regular visits to the MRS for inspections. Based on information received from Camp Ravenna as established in the IA (Appendix A), exposure hours monitoring is not administratively feasible for occupational hazards to trainees accessing the MRS; however, monitoring of any engineering controls implemented, would be conducted. The appropriate frequency for monitoring would be established to ensure the effectiveness of the remedial alternative and would result in O&M costs until UU/UE (i.e. negligible MPPEH exposure) is achieved.

Educational Controls

Based on information received from Camp Ravenna as established in the IA (Appendix A), at this MRS the educational controls would include programs that notify visitors, Camp Ravenna personnel, contractors, and utility workers of existing conditions, existing engineering controls, and potential hazards. Training (e.g., LUC awareness, hazard recognition, and reporting procedures) informs property users of the potential presence of MPPEH, stressing the importance of the 3Rs—recognize, retreat, and report. Educational controls can be implemented to provide informational materials on potential MPPEH recognition, avoidance and encounter protocols.

LUC awareness training is the Camp Ravenna-specific training provided to authorized individuals accessing the MRS. The training is described in the Property Management Plan (USACE, 2012) or the most current version. Training provides an overview of the requirements of the Property Management Plan, the procedures for preventing and reporting LUC violations, and AOC/MRS-specific restrictions. The "Land Use and Engineering Controls for each AOC/MRS" section of Appendix A of the Property Management Plan (USACE, 2012) would be updated to include a summary of LUCs developed specifically for this MRS.

The use of educational controls (annual training for facility employees, National Guard trainee in-briefs received upon arrival at Camp Ravenna, and contractor/site worker training received prior to entry on the MRS) is already being implemented by Camp Ravenna. Educational controls can be implemented easily and at a relatively low cost. Educational controls are retained for further consideration.

Summary of Land Use Controls Process Options

The educational controls LUC is considered applicable to the Fuze and Booster Quarry MRS where MPPEH was confirmed in the subsurface during the RI since it meets the evaluation criteria for effectiveness, implementability, and cost. Educational controls are carried forward as representative process options for LUCs. Although effective and technically implementable, exposure monitoring is removed from further consideration since Camp Ravenna does not expect to conduct continuous exposure hours monitoring of the MRS where no MDEH has been confirmed to date. However, periodic monitoring of any engineering controls or other LUCs implemented would be conducted and the process option is administratively implementable.

In general, LUCs may be evaluated as a sole remedy but may also be integrated to supplement implementation of an engineering remedy.

3.2.3 MPPEH Detection

MPPEH detection involves those methods and instruments used to locate munitions, including MPPEH, in the environment. Detection can include a broad-scale investigation to locate areas where MPPEH are densely clustered, or a focused-scale investigation to locate individual items. Detection is normally used in conjunction with removal and disposal (by demolition) to meet RAOs, but can also be used to identify areas for containment and/or LUCs.

Current state-of-the-art detection methods cannot detect all MPPEH. Some technologies can only detect MPPEH on the surface, and those that can detect buried MPPEH have depth limitations. In general, the deeper an item is buried and the smaller an item is, the more difficult it is to detect. The remedial technologies for MPPEH detection include surface detection and subsurface analog and subsurface digital methods. The MPPEH detection process options retained for further evaluation included instrument-aided surfaced sweeps and analog-electromagnetic (EM) and digital EM instruments. These process options are discussed below in further detail.

Surface Detection

A variety of process options can be employed to detecting MPPEH on the ground surface, but instrument-aided surface sweep was retained following the preliminary evaluation.

Instrument-Aided Surface Sweep

Instrument-aided surface sweeps consist of a systematic search for surface MPPEH with a magnetometer or other instrument that identifies metal. UXO-qualified personnel would work in well-defined search lanes that cover the entire area. This approach is necessary for areas where vegetation or other ground cover is present. It would be effective at detecting residual MPPEH on or just below the ground surface but would not be as effective at detecting MPPEH at deeper intervals. There is the potential for short-term effects from this process option for the UXO-qualified personnel due to the hazards associated with MPPEH. Instrument-aided surface sweeps is a proven and reliable option and has been conducted at other MRSs at Camp Ravenna during previous RI activities. This process is technically implementable and the materials are readily available; however, UXO-qualified personnel would be required to conduct the sweeps due to the potential for encountering MPPEH. Permission to conduct the instrument-aided surface sweeps would be easily obtained from the OHARNG which makes this process option administratively implementable. There is minimal equipment associated with this process option and the activities can be conducted quickly which makes the costs relatively low in comparison to the other MPPEH detection technologies.

Subsurface Analog Detection

Hand-held analog geophysical instruments are used in sweep mode as the instrument is passed back and forth by UXO-qualified personnel following well-defined search lanes of 5-foot wide or narrower. Analog instruments emit an audible signal as the instrument moves past metal. The UXO technician progresses along the search lane and stops when an anomaly is encountered. Anomalies identified are either flagged or immediately excavated. The subsurface analog detection process option that was retained following the preliminary evaluation was analog EM instruments.

Analog Electromagnetic (EM) Instruments

Analog EM instruments involve the use of an EM induction system to transmit electrical current that provide a detection signal. The system measures either the secondary magnetic field induced in metal objects or the difference between the electrical conductivity of the soil and the object. In addition to being able to detect ferrous MPPEH, EM instruments are capable of detecting non-ferrous MPPEH such as the aluminum casing for the 40mm practice grenade that have been found at the MRS. Detection using an analog EM instrument is likely limited to 2 to 3 feet bgs and sensitivity decreases with depth and the size of the anomaly. This process option would need to be combined with iterative removal of soil layers to achieve the subsurface RAO depth of 4 feet bgs and the confidence in being able to detect the smallest anticipated size of MPPEH at the MRS. The use of analog EM can be time consuming since all detected anomalies would be required to be investigated. There is the potential for short-term effects from this process option for the UXO-qualified personnel due to the hazards associated with MPPEH. The method is technically implementable; however, UXO-qualified personnel would be required to investigate and remove any MPPEH identified. Permission to use the analog EM instrument for subsurface detection would be easily obtained from the OHARNG which makes this process option administratively implementable. The capital cost associated with using the analog EM instrument is higher in comparison to DGM EM instrument since it is more time consuming to investigate all anomalies based on signal detection only. There are no O&M costs associated with this process option.

Subsurface Digital Detection

As opposed to analog instruments, DGM instruments log georeferenced sensor data that can be analyzed, processed, and used to identify targets with known location coordinates. Anomalies identified in the data can be analyzed to estimate the size and depth. Anomalies can be classified from most likely to least likely to be the size and shape of munitions known to have been used at the MRS. If done properly with the appropriate quality control, the number of anomalies to investigate would be reduced to create a target anomaly list. If their coordinates are known, the target anomalies could be reacquired and excavated later. Common methods for deploying geophysical sensors are man-portable systems and towed arrays. The main controlling factors for determining the appropriate method are terrain and vegetation coverage. Man-portable systems can be more successful in areas of heavy vegetation and more difficult terrain. Towed arrays are more difficult to use in areas of rugged terrain or heavy vegetation, but affords greater efficiency in open areas. The subsurface digital detection process option that was retained following the preliminary evaluation was digital EM instruments.

Digital Electromagnetic Instruments

Digital electromagnetic instruments work on the same principle as analog EM instruments, transmitting electrical current and measuring either the secondary magnetic field induced in metal objects or the difference between the electrical conductivity of the soil and the object.

The RI DGM data collection was conducted with an EM61-MK2 time domain electromagnetic instrument and was effective in detecting MPPEH on the MRS. The intrusive investigation results of the RI included a fragment of a 20mm M75 series armor-piercing tracer. This is the smallest anticipated munition potentially present at the MRS and is reliably detectable to approximately 6 inches bgs. This technology would need to be combined with iterative removal of soil layers to achieve the subsurface RAO depth of 4 feet and confidence in detection of the smallest known munition type at the MRS.

There is the potential for short-term effects from this process option for the UXO-qualified personnel due to the hazards associated with MPPEH. Additionally, significant vegetation clearing is required for this process

option and has the potential to impact wildlife and nesting habitats. This process option is technically implementable, but would require experienced geophysicists to operate the equipment and analyze the data. UXO-qualified personnel would be required to conduct the investigation of anomalies and removal of MPPEH. The use of digital EM instruments is administratively feasible, but would require approval and coordination with the OHARNG to conduct vegetation clearing in support of this process option. Although the costs for the materials and services associated with this process option is higher than for the analog EM instrument, the total cost to implement is lower since the ability to select targets can significantly reduce the level of effort in the field. There are no O&M costs associated with this process option.

Summary of MPPEH Detection Process Options

Instrument-aided surface sweep was considered the best process option for the detection of MPPEH on the ground surface since a hand-held instrument can be used to detect MPPEH in thick vegetation or areas with ground cover. This process option would require an analog EM instrument that is capable of detecting the non-ferrous (i.e., aluminum) MPPEH at the MRS. For subsurface detection of MPPEH, use of a digital EM instrument was considered as the best process option for the MRS. Both analog and digital EM instruments provide the same effectiveness and are easily implementable at the MRS; however, the ability for the EM digital instruments to collect data that can be analyzed to target the MPPEH at the MRS would result in lower operating costs for this process option and analog EM instrument is removed from further consideration. Instrument-aided surface sweeps for surface MPPEH detection and digital EM instruments for subsurface MPPEH detection meet the evaluation criteria for effectiveness, implementability, and cost are retained for further evaluation.

3.2.4 MPPEH Removal

Removal technologies involve the extraction of MPPEH from the source area to another location either on or off the MRS. Removal is used in conjunction with detection and disposal (by demolition). If it can be performed safely, removal is generally considered to be the most effective form of remediation for MPPEH. If MPPEH is no longer present at the MRS, it cannot present an explosive hazard to receptors. This makes MPPEH removal the best long-term method for reducing hazards.

MPPEH encountered at the MRS during the RI were found at individual locations from 2 to 14 inches bgs. MPPEH removal can be performed in a targeted fashion, where individual pieces are detected, identified, and removed one at a time in a focused manner. Bulk removal is not expected at this MRS because no concentrated areas of MPPEH were recovered in the intrusive investigation of the high-density area trenches. The preferred technology that was retained following the preliminary evaluation was in-situ excavation. The associated removal process options for this technology that were retained for further evaluation were manual and heavy equipment excavation.

In Situ Excavation

In situ excavation during MPPEH removal refers to the detection of and removal of MPPEH in the subsurface. The MPPEH detected is left in place with as little disturbance as possible until it is positively identified and its condition in regard to its explosive safety hazard is assessed by qualified UXO-qualified personnel. Only then is a decision made to either remove the item if determined acceptable to move or detonate it in place.

<u>Manual Excavation</u>

Manual excavation consists of hand-digging methods performed by UXO-qualified personnel. The exposure depth for the Industrial Receptor is 4 feet bgs; however, the anticipated maximum depth of MPPEH is less than 2 feet bgs. Digging at the target locations manually can easily access the anticipated depths of the

MPPEH, but this option presents short-term risks to the UXO-qualified personnel due to the hazards associated with MPPEH. These potential effects can be mitigated by establishing an exclusion zone that ensures non-UXO-qualified personnel maintain a safe distance (i.e., the Hazardous Fragment Distance {HFD]) from an anomaly when it is being investigated. For the MRS, the HFD is 395 feet based on the largest munition type recovered at the MRS, the MK1 155mm projectile.

Manual excavation is a proven and reliable process option since it was previously conducted at the MRS during the RI and was successful at the verification and removal of MPPEH. Soil at the MRS is classified as Mitiwanga Silt Loam or "pits and quarries" (CB&I, 2015). Manual excavation within the MRS would not be difficult because the soil is not difficult to hand excavate and can maintain stable slopes. Installation of erosion control devices and vegetation restoration might be required after soil and vegetation have been disturbed. The method is technically implementable; however, UXO-qualified personnel would be required to investigate and remove any MPPEH identified. Permission to conduct manual excavation would be easily obtained from the OHARNG which makes this process option administratively implementable. Although more time consuming to implement, the capital cost associated with using manual excavation is low in comparison to heavy equipment since only hand tools are required. There are no O&M costs associated with this process option.

Heavy Equipment

Heavy equipment such as excavators or other earth-moving machinery can be used to excavate subsurface MPPEH. Digging at the target locations using heavy equipment can easily access and remove the MPPEH at the anticipated depths, but this option presents short-term risks to the UXO-qualified personnel due to the hazards associated with MPPEH. These potential effects can be mitigated by establishing an exclusion zone that ensures non-UXO-qualified personnel maintain a safe distance. When heavy equipment is used, the exclusion zone (EZ) increases from the HFD to the maximum fragment distance, horizontal (MFD-H) (DoD, 2009). The EZ would increase from 395 feet to 2,876 feet. Excavation using heavy equipment is a proven and reliable process option since it was previously conducted at other MRSs at Camp Ravenna during RI field work and was successful at the verification and removal of MPPEH. The use of heavy equipment can be very disruptive to the environment due to removal of vegetation and vehicle tracking. Heavy equipment would potentially be disruptive to the banks of the ponds and vegetation within the MRS. Installation of erosion control devices and vegetation restoration might be required after soil and vegetation have been disturbed. Heavy mechanized equipment is useful when soil is so hard that use of manual excavation causes delays. However, as stated above, soil within the MRS is not expected to be difficult to excavate manually. Heavy equipment is useful when excavating areas with high concentrations of MPPEH. However, the RI did not identify areas of concentrated subsurface anomalies.

The method is technically implementable; however, UXO-qualified personnel would be required to operate the equipment and investigate and remove any MPPEH identified. The use of heavy equipment is administratively feasible, but would require approval and coordination with the OHARNG to conduct vegetation clearing in support of this process option. The capital cost associated with this process option is high in comparison to manual excavation due to equipment, fuel, and maintenance costs associated with using heavy equipment. There are no O&M costs associated with this process option.

Summary of MPPEH Removal Process Options

The maximum exposure depth for the Industrial Receptor, that is considered the Representative Receptor at the MRS, is 4 feet bgs. Heavy equipment such as a backhoe or small excavator would easily access the soils at this depth, but manual excavation was considered the most appropriate process option for in-situ

excavation primarily due to the anticipated shallow depth of the MPPEH (less than 2 feet bgs) as verified during the RI. Further, the costs associated with heavy equipment are high in comparison to manual excavation and the use of heavy equipment can be disruptive to the environment and specifically the pond banks due to over digging and the tracking of equipment. The shallow depth of MPPEH makes manual excavation a more ideal approach and mechanical excavation is removed from further consideration. Manual excavation for targeted MPPEH removal meets the evaluation criteria for effectiveness, implementability, and cost is retained for further evaluation.

3.2.5 MDEH Disposal by Demolition

Any MPPEH found at an MRS would be verified as MDAS (i.e., MD) or material documented as an explosive hazard (MDEH) by the UXO-qualified personnel. The disposal (by demolition) technologies for MDEH are used in conjunction with removal to comprise a remedial alternative. The MDEH demolition process options retained for further evaluation following the preliminary evaluation include blow-in place (BIP) and consolidated detonations.

On-Site Disposal (Within the MRS Boundary) by Demolition Blow-in-Place (BIP)

BIP is the most common method of MDEH demolition and is the safest approach since it does not require moving or transporting the item. Donor explosives charges to be used for BIP of MDEH would be delivered on an as needed basis. A donor explosive is attached to the MDEH and used to trigger a high order detonation to result in complete destruction. This process option is effective at the complete removal of MPPEH that is verified to be MDEH. There is the potential for short-term effects from this process option to the UXO-qualified personnel, the community, and the environment due to the hazards associated with MPPEH. Safety controls would be in place to mitigate the potential impacts. Following BIP, environmental testing and restoration following detonation would be required to ensure no MC impacts to the environment. This process option is technically implementable and materials and services are readily available; however, UXO-qualified personnel that are experienced in EOD procedures would be required to conduct the BIP activities. The OHARNG would be amenable to eliminating an explosive hazard at the MRS that cannot be moved and BIP is considered to be administratively feasible. The capital cost associated with BIP is low due to the minimal amount of materials required and the short-term level of effort required to conduct the BIP. There are no O&M costs associated with this process option.

Off-Site Disposal (Within the Facility Boundary) by Demolition

"On-site" demolition of MDEH is generally the only option because of the difficulties and hazards with transporting MDEH. Off-site MDEH demolition in this FS refers to the Open Demolition Area #2 site within the boundaries of Camp Ravenna, but outside of the MRS boundary. 40 CFR 300.5 and 40 CFR 300.400 explain that "on-site" is considered "the areal extent of contamination and all suitable areas in very close proximity to the contamination that are necessary for implementation of the action." In this case, that would be the MRS boundary, and consequently MDEH demolition at the Open Demolition Area #2, although within the Camp Ravenna boundary, would be defined as off-site.

Consolidated Detonations

Consolidated detonations are controlled detonations of multiple MDEH that can safely be moved to a single demolition site for destruction. Any MDEH found during the remedial action and determined as safe to move by the UXO-qualified personnel would be transferred off the MRS to a temporary magazine for storage at the

Open Demolition Area #2 site where the buried explosion module would be used to destroy the MDEH. Donor explosives charges to be used for MDEH demolition would be delivered on an as needed basis. This approach reduces the number of detonations and; therefore, limits impacts to the environment. It also allows for detonations to occur in areas where conditions are favorable for control, evacuation, and access. There is the potential for short-term effects from this process option to the UXO-qualified personnel, the community, and the environment due to the hazards associated with MPPEH. Safety controls would be in place to mitigate the potential impacts. Environmental testing and restoration would be required as part of any consolidated detonations to ensure no MC impacts to the environment. This process option is technically implementable and materials and services are readily available; however, UXO-qualified personnel that are experienced in EOD procedures would be required to conduct the consolidated shot activities. Consolidated detonation is the preferred method of MDEH demolition at Camp Ravenna and this process option is administratively feasible. The capital cost associated with consolidated detonation is low due to the minimal amount of materials required and the short-term level of effort required to conduct the consolidated detonation. There are no O&M costs associated with this process option.

Summary of MDEH Disposal (by Demolition) Process Options

Both the BIP and consolidated process options were retained for further consideration for the on-site or off-site demolition of MPPEH that is verified as MDEH since the use of either option is dependent on the condition of the MDEH and whether or not it can be moved. Both process options are considered effective for the demolition of MDEH and eliminate the need for accessing public roadways for demolition outside of the Camp Ravenna boundary. Summarily, the BIP and consolidated detonation process options meet the criteria for effectiveness, implementability, and costs and retained for further evaluation.

3.2.6 Containment

Containment includes technologies that reduce the mobility or accessibility of MPPEH. Containment technologies may mitigate the migration of MPPEH from the subsurface to the surface via frost heave. Containment may involve placing a physical barrier between the MPPEH and potential receptors. These types of technologies do not address the hazardous nature or quantity of MPPEH, they simply reduce accessibility.

Surface Barrier

Surface barriers to be installed at the MRS are intended to minimize direct contact with MPPEH by authorized personnel or trespassers and to reduce the potential for the migration and mobility of MPPEH at the MRS. The capping process options considered are natural, asphalt, and engineered covers.

Natural Cover

A natural cover includes a simple physical barrier of natural material such as soil or stone placed over the MRS. This process option would be effective at limiting or preventing the direct exposure of receptors to MPPEH as well as reduce the potential for migration and mobility of MPPEH at the MRS. There is the potential for erosion of a soil cover along the steep slopes at the west side of the MRS and scouring where fast water comes into contact with the cover. Established vegetation on a soil cover and engineering controls can help prevent erosion and scouring from occurring. The frost line for northeast Ohio is 30 inches and MPPEH was found on the ground surface during the RI; therefore, any natural cover would need to be placed to ensure there wasn't a migration potential associated with frost heave. Natural covers are easy to implement. Standard earthmoving equipment can move local soil or stone over the areas with MPPEH. The MRS will require initial clearing of vegetation and large trees. Maintenance would be required to limit large vegetative

growth that could disrupt the cover and to control erosion and scouring would be needed. Frequent maintenance (mowing) would be required. Although natural covers are technically feasible to implement, the OHARNG would not be amenable to the level of disturbance to the environment and this process option would not be administratively acceptable. The materials and services associated with natural covers are readily available and the associated capital cost is low in comparison to the other containment processes. The O&M costs are considered high in comparison to the other containment processes since frequent maintenance and inspections would be required to ensure the effectiveness of the cover.

Asphalt Cover

An asphalt cover controls direct exposure of receptors to MPPEH and the potential for migration and mobility of MPPEH through the installation of impermeable asphalt. Asphalt can quickly develop cracks and holes that need to be filled, and maintenance will be needed to repair them as they occur. These caps are most effective if the area needs to be asphalted for another use that will promote its long-term maintenance which is not the case of the MRS. Asphalt caps are easy to install and would require initial clearing of vegetation and large trees. As with other caps to control infiltration, they need to be sloped to encourage runoff during rain events. Frequent maintenance is less necessary than with the other containment process options as the asphalt caps do not require mowing. However, the asphalt cracks easily and must be controlled to maintain effectiveness. Although technically feasible to implement, installation of an asphalt cover is not consistent with the surrounding land uses at Camp Ravenna and this process option would not be administratively acceptable. The capital cost associated with materials and services of an asphalt cover is moderate in comparison to the other containment processes. The O&M costs are considered moderate since there is less frequent maintenance and inspections that would be required to ensure the effectiveness of the cover in comparison to the other containment processes.

Engineered Cover

An engineered cover consists of various layers of soil, clay, membranes and other materials. Engineered covers are applicable for the controlled direct exposure of receptors to MPPEH and the potential for the migration and mobility of MPPEH at the MRS through the installation of impermeable layer materials. Engineered covers can be effective at reducing infiltration that reduces the migration potential for MPPEH associated with frost heave. Long-term maintenance would be required for ensure cracks and holes do not develop. Maintenance will be needed to repair them as they occur. An engineered cover is more difficult to install compared to the natural or asphalt cover options due to the design requirements. As with other covers to control infiltration, they need to be sloped to encourage runoff during rain events. More maintenance is necessary with engineered covers than the asphalt cover as frequent mowing is required. The engineered cover must be controlled to maintain effectiveness. The MRS will require initial clearing of vegetation and large trees. Although engineered covers are technically feasible to implement, the OHARNG would not be amenable to the level of disturbance to the environment and this process option would not be administratively acceptable. The materials and services associated with engineered covers are specialized and are not readily available; therefore, capital cost is high in comparison to the other containment processes. The O&M costs are considered high in comparison to the other containment processes since frequent maintenance and inspections would be required to ensure the effectiveness of the cover.

Summary of Containment Process Options

The natural cover process option provides the least expensive option that meets the needs of a containment option; however, the capping option alone does not remove the MPPEH at the MRS and this process option is more susceptible to erosion and frost heave than the other containment alternatives. Established vegetation and engineering controls as well as a well-planned monitoring and maintenance program may

mitigate impacts to the cover. The asphalt cover alternative is not consistent with the surrounding areas at Camp Ravenna and there are high costs associated with the implementation of an engineered cover. Although technically feasible and effective, this GRA is not administratively feasible since it would drastically change the landscape and be unacceptable to the OHARNG. Therefore; containment GRA including natural, asphalt, and engineered covers, is removed from further consideration.

3.3 Process Options Retained for the Evaluation of Remedial Alternatives

The process options that were retained from the representative GRAs for the development of remedial alternatives are presented in Figure 3-3. The development and screening of alternatives is presented and evaluated in Section 4.0.

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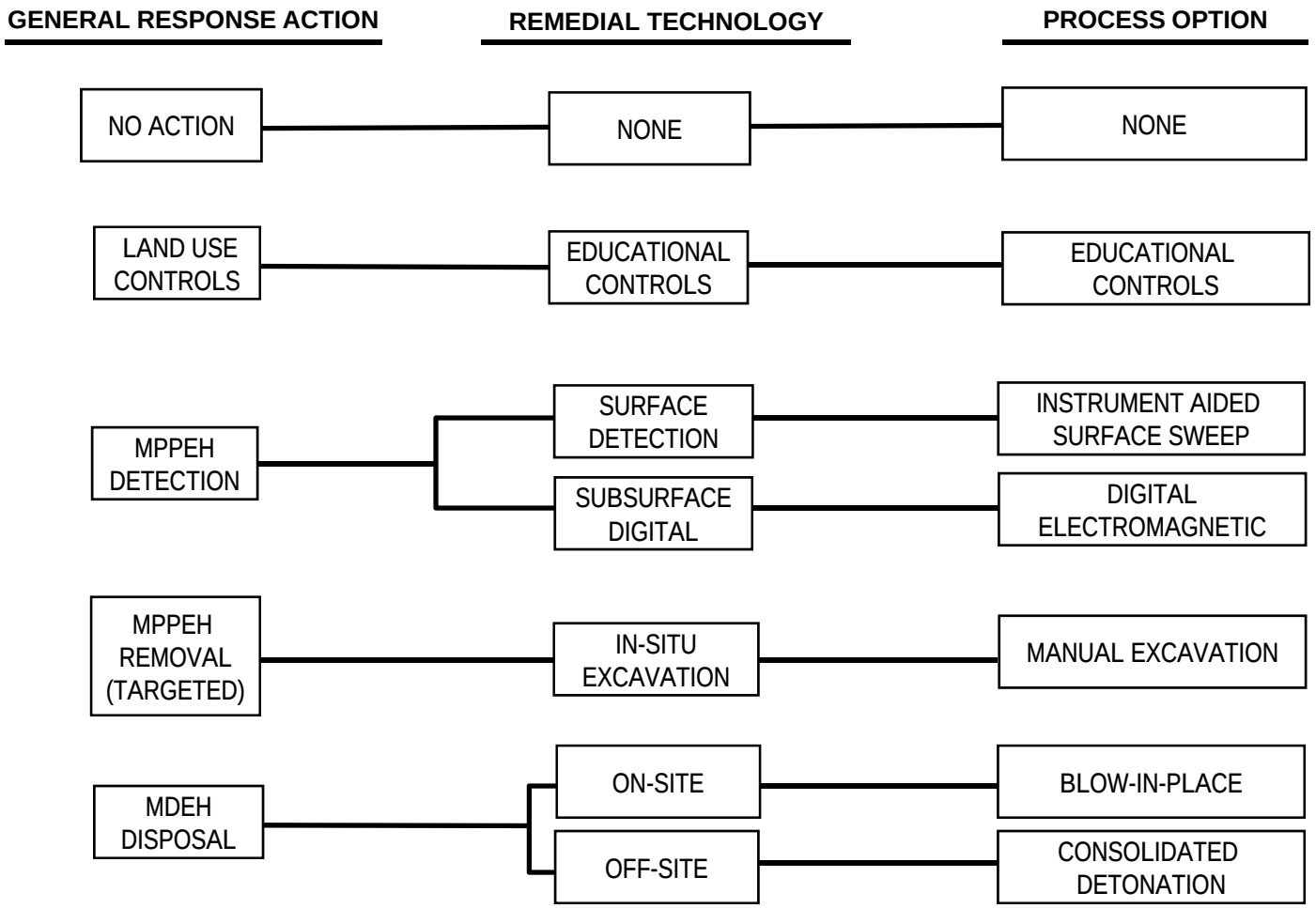
FIGURE 3-3. RETAINED PROCESS OPTIONS
RVAAP-016-R-01 FUZE AND BOOSTER QUARRY MRS



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4.0 DEVELOPMENT AND SCREENING OF ALTERNATIVES

In this section, remedial alternatives are developed by combining the remedial technologies that remain after the screening process completed in Section 3.0. Remedial alternatives are developed with the overall goals of protecting human health and the environment, and of achieving RAOs in a cost-effective manner. Development of alternatives is conducted with consideration of CERCLA Section 121(b), which shows a clear preference for remedies that are permanent, are cost-effective, and employ treatment as a principal element to reduce volume, toxicity, or mobility. Section 121(b) also states a preference against off-site transport and disposal of hazardous substances without such treatment. When hazardous substances are left on site at levels that will not allow UU/UE, Section 121(c) requires a review of the protectiveness of the remedy no less than every 5 years.

Remedial alternatives are assembled, described, and preliminarily screened in this section. Those alternatives that meet the three criteria listed below are retained for more thorough and extensive analysis in Section 5.0:

- Effectiveness is the ability of an alternative to protect human health and the environment in the short term (during remedial action) and long term (after remedial action). Measures of effectiveness include (1) the degree to which toxicity, mobility, or volume are reduced through treatment; (2) the degree to which adverse effects on human health and the environment are controlled; (3) timeliness; and, (4) compliance with ARARs. Alternatives that do not provide adequate protection of human health and the environment are eliminated from further consideration [40 CFR 400.430(e)(7)(i); USEPA, 1988].
- Implementability is the ability to implement a remedial alternative at an MRS, and is composed of its technical and administrative feasibility. The technical feasibility of an alternative refers to the level of effort required to construct, operate, and meet technology-specific regulations for process options until the remedial action is complete. Administrative feasibility addresses the acceptability of an alternative by regulatory agencies/stakeholders and includes tasks such as obtaining approvals from stakeholders and establishing easements. Implementability also considers the availability of resources required to implement specific components of an alternative and the ability to obtain them.
- Costs consist of capital costs associated with up-front implementation and long-term O&M including ongoing implementation and/or monitoring costs. Ranges or approximations of relative capital and O&M costs are used rather than detailed estimates. Present worth analyses are used to evaluate those expenditures that occur over different time periods. All costs are discounted to a common base year. Alternatives can be eliminated when their costs are deemed excessive relative to their overall effectiveness. Alternatives that provide effectiveness and implementability like those of other alternatives, but at a greater cost, can also be eliminated (40 CFR 400.430(e)(7)(iii); USEPA, 1988).

4.1 Development and Screening of Alternatives

This section identifies potential remedial alternatives to be screened for the Fuze and Booster Quarry MRS. Several alternatives were developed and preliminarily considered to address the RAOs for the MRS. The alternatives are as follows:

- Alternative 1 - No Action;
- Alternative 2 - LUCs;

- Alternative 3 - Surface MPPEH Removal and LUCs; and
- Alternative 3 - Surface and Subsurface MPPEH Removal (UU/UE).

4.2 Screening of Individual Alternatives

This section presents the preliminary screening of the Alternatives developed in Section 4.1.

4.2.1 Alternative 1 - No Action

The NCP requires that a No Action alternative be evaluated to provide a baseline for comparison to other alternatives. This alternative provides no actions to protect human health or the environment at the MRS. As this is required per the NCP, no preliminary screening is necessary, and this alternative is retained for detailed analysis in Section 5.0.

4.2.2 Alternative 2 - Land Use Controls

The LUCs alternative includes no active MPPEH removal at the MRS. Rather, it focuses on reducing human exposure to MPPEH by managing the activities occurring at the MRS. The LUCs alternative includes educational controls developed through the IA (Appendix A), as described below. This section focuses on specifics of the LUCs identified that impact effectiveness, implementation, and cost.

The educational controls to be implemented for the Fuze and Booster MRS would include an annual training program that notifies authorized personnel of existing conditions, existing engineering controls, potential MPPEH hazards at the MRS, and reporting procedures that informs the authorized personnel of the potential presence of MPPEH. The reporting procedures would stress the importance of the 3Rs—recognize, retreat, and report. Five-Year Reviews conducted by OHARNG would be required to ensure the effectiveness of this alternative since it does not achieve UU/UE at the MRS. The Industrial Receptor is considered the Representative Receptor for any activities that may occur at the MRS. Any MPPEH that are located on the MRS during current and future activities are handled (destroyed) based on Camp Ravenna procedures. Those procedures are part of the briefings currently given to all receptors, and include reporting MPPEH (confirmed to be MDEH) to Camp Ravenna Range Control, followed by MPPEH demolition conducted by Explosive Ordnance Disposal personnel.

Effectiveness: Alternative 2 would not reduce mobility or volume of MPPEH through treatment and the hazards would remain at the MRS. Toxicity concerns associated with MPPEH would be reduced through any MPPEH (confirmed to be MDEH) being reported to Camp Ravenna Range Control, followed by demolition conducted by Explosive Ordnance Disposal personnel. Educational controls consisting of annual training would be effective at mitigating the short-term hazards at the MRS, once implemented, by educating the Industrial Receptor who may have access to the MRS about potential hazards; however, they are not effective for unauthorized personnel or trespassers who are unaware of the hazards at the MRS. This alternative would be effective at protecting human health in the short-term because no active work would be performed at the MRS. Alternative 2 would present a short-term hazard to Explosive Ordnance Disposal personnel handling and destroying MDEH.

The overall and long-term effectiveness of the LUCs depends on the support, involvement, and willingness of the government agencies with jurisdiction to enforce and maintain the educational controls emplaced to modify behavior. ARNG has authority to effectively maintain and enforce LUCs at Camp Ravenna; however,

ARNG, as a national institution, has delegated that authority to OHARNG at Camp Ravenna. LUC Awareness Training is already in place as an interim control for the MRS, and OHARNG is willing to maintain educational controls over the long term. Because the MRS will remain under OHARNG control, Alternative 2 would be effective in the long-term. There is no chemical-specific, location-specific, or action-specific ARARs identified for this alternative.

Implementability: Land use controls are considered technically and administratively feasible for the Fuze and Booster Quarry MRS. The use of educational controls (annual training for OHARNG/Camp Ravenna employees, National Guard trainee in-briefs, and contractor/site workers training prior to MRS access) is being implemented by Camp Ravenna as a required procedure. The materials and services that will be required to implement the LUCs are readily available.

Cost: The implementation costs for Alternative 2 include the incorporation of the LUC requirements into the *Camp Ravenna Property Management Plan*, which is already funded (and will be completed) under an existing project. Other capital costs include the Land Use Control Implementation Plan ($9,758) and the first annual occurrence of the training activities for the MRS ($5,057) for total capital costs of $20,445. The duration of initial preparation through final approval of the Land Use Control Implementation Plan will be six months. The duration of the training activity includes 2 days of training for Camp Ravenna personnel provided by a UXO technician. The O&M costs (annual LUC Awareness Training of $2,795) are estimated over a 30-year performance period and the discounted O&M costs over this time frame is $56,227. The total present worth of Alternative 2 is $76,672. The duration of the Five-Year Reviews will include a one day site visit for the enhanced visual survey and six months for initial preparation through final approval of the Five-Year Review Report. The Five-Year Reviews that are required since UU/UE will not be achieved are $23,010 each. The total present worth of performing Five-Year Reviews and incidental destruction of MDEH over 30 years is $128,141.

Overall Evaluation: Alternative 2 is implementable as educational controls are already being implemented by Camp Ravenna. Additionally, Alternative 2 would be effective because the MRS would remain under OHARNG control, and OHARNG is willing to maintain educational controls over the long term. Costs associated with Alternative 2 are considered reasonable relative to the overall effectiveness of Alternative 2. Alternative 2 is therefore retained for further evaluation in Section 5.0.

4.2.3 Alternative 3 - Surface MPPEH Removal and LUCs

Alternative 3 would use instrument-aided surface sweep methods to remove all MPPEH exposed at, or just below, the ground surface. A surface removal is much less expensive than a subsurface removal because little or no excavation is required. Alternative 3 would not lead to unrestricted use of the property (i.e., UU/UE), but it would be an effective way to decrease the hazard sufficiently to allow certain land uses that do not involve intrusive activities in the short-term.

Surface MPPEH Detection is the first step in surface MPPEH removal, which would be accomplished with instrument-aided surface sweep. On the pond shoreline areas, where there is minimal vegetation, the surface MPPEH removal could be performed based on visual inspection. UXO-qualified personnel would systematically walk the MRS and mark, identify, and record the locations of all MPPEH found on the surface for removal or subsequent demolition.

The search would be conducted with a hand-held analog EM instrument. The operator would systematically search sweep lanes within grids using the EM instrument to identify anomalies. If the instrument indicates a response but the item is not found at the ground surface, the UXO technician would move on without digging into the subsurface. If an MPPEH item is discovered, the removal process discussed below would be followed. If the item is determined to be cultural debris (trash), it would be collected for disposal.

Before surface MPPEH detection operations could begin, some degree of vegetation removal would be required to reduce vegetation to a height necessary to allow for proper operation of MPPEH detection equipment and to provide the required ground visibility for the safety of UXO-qualified team. Within approximately 2.5 acres of the MRS, cutting of thick grass and small trees no larger than 3 inches in diameter would be necessary for MPPEH detection operations.

MPPEH Removal on the ground surface would be performed by UXO-qualified personnel intrusively investigating visually detected anomalies confirmed by the hand-held analog EM instrument. If the MPPEH was partially exposed, or protruding above the surface, limited digging with hand tools would be conducted. During this time, all nonessential personnel would be evacuated to the HFD of 395 feet (DoD, 2009). Excavations would be backfilled, and seeding or other site restoration would be completed. Appropriate fire control measures (fire extinguishers available, proper segregation of flammable and combustible materials, no smoking or open flame allowed, vehicles would not be parked or left idling over vegetation, and the fire-fighting emergency contact numbers available to teams) would be in place to prevent fire, especially during dry conditions. All MDAS and debris would also be collected for disposal so that it does not remain in the environment. It is not anticipated that MPPEH removal activities under Alternative 3 would greatly disturb the environment since only MPPEH on or just below the ground surface would be investigated.

MPPEH Demolition would be performed on all MPPEH discovered. Any MPPEH found would be verified as MDAS or MDEH by the UXO-qualified personnel. Any MDEH would be evaluated by the UXO-qualified personnel whether it is safe to move for consolidated detonation or if requires BIP. Consolidated detonation is the preferred method for MDEH demolition at Camp Ravenna since the event can be managed at a controlled location at the Open Demolition Area #2 area. MDEH considered safe to move would be transported off the MRS to temporary magazines that are located at Open Demolition Area #2. MDEH that is not deemed safe would be BIP. All notifications and procedures for consolidated detonation or BIP will be conducted in accordance with the procedures established for Camp Ravenna. This would include establishing a fixed demolition area, evacuating non-essential personnel to the highest HFD for the MDEH to be detonated, and conducting pre- and post-environmental sampling to ensure no MC is present. Any pits or holes created by the detonation would be backfilled and seeded with a Camp Ravenna-approved seed mix. All MD would be collected for off-site disposal for flashing and recycling. Other debris would be transported off-site for disposal or recycling as non-hazard municipal waste.

LUCs are included in this alternative since MPPEH would remain in the subsurface after the surface removal. The LUCs would consist of educational controls (i.e., annual training) for the Industrial Receptor that would control human intrusion in the subsurface at the hazardous areas. In the short-term, this may allow the MRS to be available for certain land uses that don't involve intrusive activities.

Effectiveness: Alternative 3 would be effective at reducing the volume by the surface removal of MPPEH through treatment; however, the degree of removal would likely be minimal since all of the MPPEH found during the RI was buried in the subsurface. The mobility of MPPEH at the MRS would not be reduced since it would potentially remain in the top 30 inches of soil and would be susceptible to freeze/thaw cycling or

erosion. Toxicity concerns associated with MPPEH would be reduced through MPPEH removal. No hazards are posed to the environment by the presence of MPPEH and Alternative 3 would be protective of human health in the short-term by removing MPPEH on the ground surface. LUCs would be protective of human health in the long-term by mitigating receptor access to the MRS where subsurface MPPEH would remain or potentially migrate to the surface via freeze/thaw cycling or erosion. Effective pre-planning and the implementation of the applicable procedures for MDEH responses are protective of the UXO-qualified personnel that would conduct the work at the MRS. These procedures include the Engineering Regulation (ER) 385-1-5, *Safety and Health Requirements for Operations and Activities Involving Munitions and Explosives of Concern* (2014) and DoD 6055.09-STD, *Ammunition and Explosives Safety Standards* (2008). The overall long-term effectiveness of Alternative 3 depends on the support, involvement, and willingness of the government agencies with jurisdiction to enforce and maintain the educational controls emplaced to modify behavior. ARNG has authority to effectively maintain and enforce LUCs at Camp Ravenna; however, ARNG, as a national institution, has delegated that authority to OHARNG at Camp Ravenna. LUC Awareness Training is already in place as an interim control for the MRS, and OHARNG is willing to maintain educational controls over the long term. Because the MRS would remain under OHARNG control, LUCs under Alternative 3 would be effective in the long term. There are no chemical-specific or location-specific ARARs identified for Alternative 3. One action-specific ARAR, Erosion and Sediment Control (OAC 1501:15-1-04), would apply following vegetation clearance.

Implementability: This type of removal action is technically and administratively feasible to implement, with an estimated time of approximately 1 year for planning and implementation. Vegetation removal would be necessary, equating to approximately 2.5 acres of the MRS. This may result in short-term impacts to the environment, wetlands, and local habitats at the MRS; however, rapid regrowth of the vegetation is expected. Camp Ravenna vegetation removal restrictions for the northern long-eared bat would also be followed, in that vegetation/trees greater than 3 inches in diameter may not be cut during summer roosting season between April 1 and September 30. Soil disturbance would be minimal since excavation of subsurface anomalies would be conducted by hand-digging only. Storm water controls would be required following vegetation clearing to minimize soil erosion, per the Construction and Development Effluent Guidelines. This alternative would require approvals from the OHARNG for any activities that have the potential to impact wetlands, habitats during the nesting season, and any vegetation clearing activities would be conducted outside of the nesting seasons to minimize any impacts. The materials and services that will be required to implement the LUCs are readily available.

Cost: The implementation costs for Alternative 3 include the development of the planning documents and support for the surface MPPEH removal action. The incorporation of the LUC requirements into the *Camp Ravenna Property Management Plan* is currently funded under a separate project. The capital costs include the work plans and relevant safety plans ($76,292), the mobilization/demobilization of personnel ($9,451), the field activities ($72,916), and the LUC Awareness training activities for the MRS ($5,090). The duration for initial preparation through final approval of the work plan and explosive safety submission will be nine months. The duration of field activities includes 15 days for mobilization/demobilization, surveying, vegetation removal, surface clearance, and site restoration. The duration of the initial preparation through final approval of the remedial action completion report will be six months. The Five-Year Reviews that are required since UU/UE will not be achieved are $23,010 each, over a 30 year period for a total present worth of $128,141. The total present worth of Alternative 3 is $586,947.

Overall Evaluation: Alternative 3 includes initial surface removal of MPPEH; however, does not address subsurface MPPEH. There are no follow-up actions to inspect or remove MPPEH that has the potential to

become exposed via freeze/thaw cycles at the MRS. LUCs consisting of educational controls (i.e., training) would still need to be implemented to ensure the long-term effectiveness and protection of human health for this alternative. Therefore, Alternative 3 provides the same effectiveness and implementability as Alternative 2, which provides for LUCs only, but at a greater cost. Based on these considerations, Alternative 3 is removed from further evaluation in this FS.

4.2.4 Alternative 4 - Surface and Subsurface MPPEH Removal (UU/UE)

Alternative 4 would use DGM and manual digging to investigate and remove all surface and subsurface MPPEH at the MRS to the maximum exposure depth of 4 feet bgs for the Industrial Receptor. Manual digging is the preferred method of MPPEH removal for this alternative since the maximum depth of MPPEH found during the RI was at 12 inches bgs. Successful completion of this alternative would achieve UU/UE at the MRS. Under Alternative 4, UU/UE is defined as complete MPPEH removal that allows for unrestricted access and activities for the Industrial Receptor at the MRS.

MPPEH Detection would be accomplished with 100 percent coverage with DGM, which is capable of detecting the MPPEH for the MRS between ground surface and 4 feet bgs. An Initial DGM survey would be performed using several DGM sensors combined into a towed array pulled by an all-terrain vehicle, or a man-portable system. This would allow rapid data collection with minimal personnel, resulting in a digital, georeferenced map of the entire MRS. The data would be collected, processed, evaluated, and analyzed to select target anomalies likely to represent munitions of interest within the upper 4 feet that is the maximum exposure depth for the Industrial Receptor. Where an isolated target anomaly is present, the coordinates would be located again and the anomaly would be "reacquired" to precisely pinpoint its location with a pin flag for subsequent removal.

In areas where DGM data indicates a concentration of subsurface anomalies, the area will be designated as a polygon. UXO-qualified personnel with analog magnetometers would perform a mag and dig operation by systematically sweeping the instrument back and forth in search lanes within the polygon. When an audible response is encountered, the UXO technician would immediately excavate and identify the metal. If identified as MPPEH, the removal process discussed below would be followed. If the metal is determined to be cultural debris, it would be collected for disposal.

Vegetation removal of tall grasses, scrub brush, and possibly small trees less than 4 inches in diameter would be required on 2.5 acres of the MRS to clear the ground surface to the extent necessary to allow for proper operation of MPPEH detection equipment and to provide the required ground visibility for the safety of UXO-qualified personnel. The vegetation and small trees will only be removed to an acceptable height (i.e., less than 4 inches) to allow for adequate data collection by the DGM instruments.

MPPEH Removal would be performed with shovels and other hand tools to minimize impact to the MRS landscape. UXO-qualified personnel would investigate each anomaly and mark, identify, and record the locations of all MPPEH for removal or subsequent demolition. During this time, all nonessential personnel would be evacuated to the HFD of 395 feet (DoD, 2009). Excavations would be backfilled, and seeding or other site restoration would be completed. It is not anticipated that the manual excavation activities would greatly disturb the environment; however, each of the excavation areas would be regraded and seeded with a Camp Ravenna-approved seed mix to ensure regrowth.

MPPEH Demolition would be performed on all MPPEH discovered. Any MPPEH found would be verified as MDAS (i.e., MD) or MDEH by the UXO-qualified personnel. Any MDEH would be evaluated by the UXO-qualified personnel whether it is safe to move for consolidated detonation or if requires BIP. Consolidated detonation is the preferred method for MDEH demolition at Camp Ravenna since the event can be managed at a controlled location at the Open Demolition Area #2 area. MDEH considered safe to move would be transported off the MRS to temporary magazines that are located at Open Demolition Area #2 area. MDEH that is not deemed safe would be BIP. All notifications and procedures for consolidated detonation or BIP will be conducted in accordance with the procedures established for Camp Ravenna. This would include establishing a fixed demolition area, evacuating non-essential personnel to the highest HFD for the MDEH to be detonated, and conducting pre- and post-environmental sampling to ensure no MC is present. Any pits or holes created by the detonation would be backfilled and seeded with a Camp Ravenna-approved seed mix. All MDAS would be collected for off-site disposal for flashing and recycling. Other debris would be transported off-site for disposal or recycling as non-hazard municipal waste.

Effectiveness: Alternative 4 would be effective at reducing the mobility and volume of MPPEH through treatment to a negligible probability of exposure (i.e., UU/UE) which is a CERCLA preference. Surface and subsurface removal of MPPEH to the maximum exposure depth of 4 feet bgs for the Industrial Receptor would be protective of human health and the environment. Effective pre-planning and the implementation of the applicable procedures for MDEH responses are protective of the UXO-qualified personnel conducting the work at the MRS. These procedures include the ER 385-1-5, *Safety and Health Requirements for Operations and Activities Involving Munitions and Explosives of Concern* (2014) and DoD 6055.09-STD, *Ammunition and Explosives Safety Standards* (2008). The alternative would provide long-term effectiveness by eliminating any future potential exposure to MPPEH at the MRS. Similar to Alternative 3, there are no chemical-specific or location-specific ARARs, but one action-specific ARAR, Erosion and Sediment Control (OAC 1501:15-1-04), would apply following vegetation clearance.

Implementability: This type of removal action would be technically and administratively feasible to implement, with an estimated time of approximately 1 year for planning and implementation. There would be impacts to the MRS soil where MPPEH is manually excavated, and where BIP occurs. In order to implement this alternative and to achieve complete DGM coverage at the MRS, ground vegetation and trees less than 4 inches in diameter would need to be removed. This will result in medium to long-term impacts which may take several years for nesting and other wildlife habitats to become re-established at the MRS. Camp Ravenna vegetation removal restrictions for the Northern long-eared bat would also be followed, in that vegetation/trees greater than 3 inches in diameter may not be cut during summer roosting season between April 1 and September 30. Soil disturbance would be minimal since excavation of subsurface anomalies would be conducted by hand-digging only. Storm water controls would be required following vegetation clearing to minimize soil erosion, per the Construction and Development Effluent Guidelines for storm water controls. This alternative would require approvals from the OHARNG for any activities that have the potential to impact wetlands, habitats during the nesting season, and any vegetation clearing activities would be conducted outside of the nesting seasons to minimize any impacts.

Cost: The implementation costs for Alternative 4 include the development of the planning documents and safety documents ($108,220), mobilization and demobilization of personnel ($32,886), completion of the field activities ($186,153) for a total of capital costs of $451,616. The duration for initial preparation through final approval of the work plan and explosive safety submission will be nine months. The duration of the field activities includes 20 days for mobilization/demobilization, surveying, vegetation removal, digital geophysical mapping, reacquisition and intrusive investigation, and site restoration. The duration of the initial preparation

through final approval of the remedial action completion report will be six months. Since this alternative achieves UU/UE, there would be no need for costs to implement LUCs, conduct O&M, or prepare Five-Year Reviews. The Total Capital costs for Alternative 4 is $451,616.

Overall Evaluation: Alternative 4 is effective and implementable and costs are considered reasonable relative to overall effectiveness. Therefore, Alternative 4 is retained for further evaluation in Section 5.0.

5.0 DETAILED ANALYSIS OF ALTERNATIVES

In this section, the remedial alternatives developed in Section 4.0 and retained for further evaluation are analyzed in detail. The detailed analysis consists of evaluating each alternative using the nine criteria listed in the NCP. The purpose of this detailed analysis of alternatives is to provide performance and cost data that can be utilized to provide a basis for optimal remedy selection.

5.1 Overview of Evaluation Criteria

Section 300.430(e) of the NCP lists nine CERCLA criteria against which each remedial alternative must be assessed. The acceptability or performance of each alternative against the criteria is evaluated individually so that relative strengths and weaknesses may be identified.

The NCP (Section 300.430(f)) states that the first two criteria, protection of human health and the environment and compliance with ARARs, are "threshold criteria" that must be met by the selected remedial action unless a waiver is granted under Section 121(d)(4) of CERCLA. The next five criteria are "primary balancing criteria," and the trade-offs within this group must be balanced. The preferred alternative will be the alternative that is protective of human health and the environment, is ARAR-compliant, and provides the best combination of primary balancing attributes. The final two criteria, state and community acceptance, are "modifying criteria" that are evaluated following the comment period on the FS report and the proposed remedial plan. The detailed criteria are as follows:

Threshold Criteria:

Overall Protection of Human Health and the Environment – A determination and declaration that this criterion will be met by the proposed remedial action must be made in the ROD; therefore, the selected remedy must meet this threshold criterion. The threshold criterion will be met if the risks associated with human exposures are eliminated, reduced, or controlled through treatment, engineering, or LUCs, and if the remedial action is protective of the environment.

Compliance with ARARs – Compliance with ARARs is a threshold criterion that must be met by the proposed remedial action. The remedial alternative will meet this criterion if all chemical-specific, action-specific, and location-specific ARARs are met by the alternative. For those ARARs that are not met, a determination will be made as to whether a waiver is appropriate. It should be noted that the ARARs presented in this document are preliminary. Final ARARs and compliance determinations will be made in the ROD.

Balancing Criteria:

Long-Term Effectiveness and Permanence – The level of risk associated with MPPEH and treatment residuals after implementation of the remedial alternative will be evaluated.

- Magnitude of residual hazards remaining from untreated waste or treatment residuals remaining at the conclusion of the remedial activities; and
- Adequacy and reliability of controls such as containment systems and institutional controls necessary to manage treatment residuals and untreated waste.

Reduction of Toxicity, Mobility, or Volume Through Treatment – The statutory preference for remedial technologies that significantly and permanently reduce the toxicity, mobility, or volume of the waste is addressed by this criterion. The following factors will be considered:

- The amount of hazardous materials that will be destroyed or treated;
- The degree of expected reduction in toxicity, mobility, or volume;
- The degree to which the treatment will be irreversible;
- The type and quantity of treatment residuals that will remain following treatment;
- Treatment processes the alternatives employ and the materials they will treat; and
- Degree to which treatment reduces the inherent hazards posed by the principal threats at the MRS

Short-Term Effectiveness – The effects of the remedial alternative from the beginning of construction and implementation to the completion of the remedial alternative are addressed under this criterion. The following factors will be addressed.

- Protection of the community during the remedial action, such as protection from intentional and unintentional detonations, transportation of contaminated materials, and air-quality impacts from disposal or treatment within the MRS;
- Potential impacts on workers during the remedial action and the effectiveness and reliability of any protective measures;
- Environmental impacts of the remedial action and the effectiveness and reliability of mitigating measures; and,
- Time required to achieve the remedial response objectives.

Implementability – The technical and administrative feasibility of implementing the remedial action will be addressed. Technical feasibility refers to the ability to construct, reliably operate, and meet technology-specific regulations for process options until a remedial action is complete; it also includes operation, maintenance, replacement, and monitoring of technical components of an alternative, if required, into the future after then 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 the requirements for, and availability of, specific equipment and technical specialists.

Cost – Capital and long-term management (LTM) costs are estimated for each alternative based on quotes for labor, materials, and equipment necessary to implement the alternative. For annual LTM costs, the net present value is calculated over the expected number of years it will take to implement the alternative based on real discount rates (similar to interest rates) that vary according to the period of performance for federal projects. For those alternatives that could take 30 or more years to complete, a period of 30 years is used for estimating LTM costs as specified in USEPA's RI/FS guidance (USEPA, 1988). USEPA provides guidelines for estimating remedial alternative costs in Office of Solid Waste and Emergency Response (OSWER) Directive 9355.0-75 (USEPA, 2000). These cost estimates are intended to have an accuracy of +50/-30 percent. Cost estimating assumptions, unit costs, and real discount rates, which vary according to the period of performance, associated with implementation of the remedial alternatives included in Section 5.0 are provided in Appendix B.

Modifying Criteria:

State Acceptance – This criterion will be evaluated during incorporation of regulatory review comments into this FS, and during the future submittals of the Proposed Plan and Record of Decision.

Community Acceptance – This criterion will be evaluated when the Proposed Plan is presented to the public for review and comment.

5.2 Individual Analysis of Alternatives

Four alternatives were developed and carried forward to address MPPEH for the Fuze and Booster Quarry MRS. These alternatives are as follows:

- Alternative 1 – No Action;
- Alternative 2 – LUCs; and
- Alternative 4 – Surface and Subsurface MPPEH Removal (UU/UE).

The following sections provide a detailed analysis of these alternatives according to the nine NCP criteria. Table 5-1, presented at the end of this section, summarizes the evaluation of the first seven NCP criteria for each alternative.

5.2.1 Alternative 1 - No Action

Description – This alternative assumes no further action would be taken to address RAOs. This alternative is provided as a baseline for comparison to the other remedial alternatives as required under CERCLA and the NCP.

Overall Protection of Human Health and the Environment – The No Action alternative does not decrease the explosive hazards to industrial receptors due to the presence of surface and subsurface MPPEH because no remedial activities would be implemented at the MRS. Potential hazards associated with direct contact through handle/tread underfoot and direct contact through intrusive activities are not addressed. No hazards are posed to the environment by the presence of MPPEH. This alternative is not protective of human health and does not meet this criterion.

Compliance with ARARs – There are no chemical-specific, location-specific, or action-specific ARARs identified for this alternative. Because no actions will be implemented under Alternative 1, no location- or action-specific ARARs are triggered. Therefore, Alternative 1 meets this criterion.

Long-Term Effectiveness and Permanence – In the long term, this alternative would not be effective. No actions would be taken to reduce explosive hazards and reduce exposure to residual MPPEH. No actions would be taken to reduce the magnitude of or otherwise manage the explosive hazards associated with residual MPPEH.

Reduction of Toxicity, Mobility, or Volume through Treatment – No treatment is employed as part of the No Action alternative. As a result, this alternative would not satisfy the statutory preference for employing

treatment as a principal element. This alternative would not reduce the toxicity, mobility, or volume of MPPEH remaining in the surface/subsurface.

Short-Term Effectiveness – Because no active remediation activities are conducted, no additional hazards above those associated with the residual MPPEH would be posed to current receptors or the future industrial receptor as a result of implementing this alternative. This alternative would not inflict any adverse short-term effects on the environment.

Implementability – The No Action alternative does not involve active remediation; therefore, technical feasibility is not a consideration. This alternative will not interfere with any planned remedial action in the future. This alternative is not administratively feasible to OHARNG, as no reduction in explosive hazards would occur.

Cost – The No Action alternative does not have any capital or O&M costs associated with it.

State Acceptance – This criterion will be evaluated during incorporation of regulatory review comments into this FS, and for the future submittals of the Proposed Plan and Record of Decision.

Community Acceptance – This criterion will be evaluated when the Proposed Plan is presented to the public for review and comment.

Overall Evaluation – Although No Action is technically implementable and there are no costs, this alternative would not mitigate potentially remaining MPPEH hazards. As a result, this alternative is not protective of human health and the environment, and does not reduce the hazard of an Industrial Receptor encountering MPPEH in surface or subsurface soil via direct contact to a negligible probability. As a result, Alternative 1 would not meet the RAOs.

5.2.2 Alternative 2 - Land Use Controls

Description – The LUCs alternative includes no active remediation of the MRS. Rather, it focuses on reducing human exposure to MPPEH by managing the activities occurring at the MRS. Alternative 2 includes educational controls and monitoring. The educational controls consist of annual training for authorized personnel who would be working at or in the vicinity of the MRS. The training would include LUC awareness, hazard recognition, and reporting procedures for any MPPEH found at the MRS. Monitoring would be conducted in support of the CERCLA Five-Year Review and would evaluate the conditions at the MRS and ensure that the LUCs are protective of potential human receptors.

Overall Protection of Human Health and the Environment – The LUCs alternative would not actively treat or remove MPPEH at the MRS; however, it would isolate the Industrial Receptor from potential exposure to the MPPEH through behavior controls to prevent contact with MPPEH (i.e., LUC awareness, hazard recognition, and response). No hazards are posed to the environment by the presence of MPPEH. This alternative is protective of human health and meets the criteria.

Compliance with ARARs – There are no chemical-specific, location-specific, or action-specific ARARs identified for this alternative. Therefore, Alternative 2 meets this criterion.

Long-Term Effectiveness and Permanence – The LUCs alternative does not involve active treatment or removal of MPPEH from the MRS. The potential exists for incidental removal of MPPEH, if MPPEH is identified during future activities. This MPPEH (determined to be MDEH) would be destroyed by Explosive Ordnance Disposal personnel under Camp Ravenna current procedures. In the absence of an active remedy or removal process, MPPEH would remain in place at the MRS above levels that allow for UU/UE. The LUCs would reduce the magnitude of residual hazards by mitigating exposure to the subsurface MPPEH by providing the Industrial Receptor with the information necessary to recognize and avoid the hazards at the MRS. The LUCs would require continual implementation to ensure long-term effectiveness. As summarized in the IA (Appendix A) ARNG has the financial capability, and both ARNG and OHARNG have the willingness to implement LUCs. Therefore, the LUCs would be adequate and reliable controls in the management of residual hazards associated with the MRS, and long-term effectiveness would be ensured. Five-Year Reviews would be necessary until UU/UE (i.e., negligible probability of a hazard) is achieved to verify this alternative remains effective.

Reduction of Toxicity, Mobility, or Volume through Treatment – This alternative would not involve active treatment, containment, removal, or disposal (by demolition) of MPPEH. Because no treatment would be implemented, other than incidental destruction of MPPEH, there would be no reduction in mobility or volume. Toxicity concerns associated with MPPEH would be reduced at the MRS through any incidental destruction of MPPEH (confirmed to be MDEH) being reported to Camp Ravenna Range Control, followed by MDEH demolition conducted by Explosive Ordnance Disposal personnel. As a result, this alternative does not satisfy the statutory preference for employing treatment as a principal element.

Short-Term Effectiveness – The short-term hazards posed to the Industrial Receptor at the MRS are contact with surface/subsurface MPPEH. The implementation of the LUCs that includes hazard awareness, recognition, and response at the MRS reduces the risk of exposure in the short-term for Industrial Receptor by providing them with the necessary information to identify and mitigate the potential for direct contact with MPPEH. The UXO-qualified personnel that would respond to and remove any MPPEH found are required to have specialized training that would mitigate the short-term explosive hazards for these responders. The implementation of LUCs would not introduce short-term risks to the community and the environment would not face additional adverse impact due to construction activities such as erosion, sedimentation, or vegetative damage. The alternative's remedial measures would require zero years to complete and would include an O&M period (30 years assumed for cost estimating purposes).

Implementability – This alternative does not involve active remediation; therefore, technical feasibility is not a consideration. This alternative will not interfere with any planned remedial action in the future. Preparing an appendix to the *Camp Ravenna Property Management Plan* and implementing the LUCs (annual training and monitoring for the Five-Year Review) is technically implementable and administratively feasible. Consultation and approval of this remedy by the Ohio EPA as the final remedy would be required.

Cost – The implementation costs for Alternative 2 include the incorporation of the LUC requirements into the *Camp Ravenna Property Management Plan*, which is already funded under an existing project. Other capital costs include the Land Use Control Implementation Plan ($9,758) and the first annual occurrence of the training activities for the MRS ($5,057). The Five-Year Reviews that are required since UU/UE will not be achieved are $23,010 each, for a total present worth over 30 years of $128,141. The O&M costs (annual LUC Awareness Training of $2,795) are estimated over a 30-year performance period and the discounted O&M costs over this time frame is $56,227. The total present worth of Alternative 2 is $76,672. The detailed breakdown of these costs is provided in Appendix B.

State Acceptance – This criterion will be evaluated during incorporation of regulatory review comments into this FS, and for the future submittals of the Proposed Plan and Record of Decision.

Community Acceptance – This criterion will be evaluated when the Proposed Plan is presented to the public for review and comment.

Overall Evaluation – Alternative 2 takes action to mitigate potentially remaining MPPEH risks at the MRS through behavior controls to prevent contact of the Industrial Receptor with the MPPEH. This alternative is technically implementable and administratively feasible and is protective of human health. No hazards are posed to the environment by the presence of MPPEH. Educational controls would prevent the Industrial Receptor from direct contact with surface and subsurface MPPEH. These controls would reduce the unacceptable hazard of MPPEH at the MRS such that the likelihood of a receptor encountering MPPEH via direct contact would be negligible. As a result, Alternative 2 would meet the RAOs.

5.2.3 Alternative 4- Surface and Subsurface MPPEH Removal (UU/UE)

Description –Alternative 4 includes the systematic search and removal of all MPPEH on the surface and within 1 foot bgs, the maximum anticipated depth of MPPEH, utilizing full-coverage DGM and manual excavation of target anomalies. Under this alternative, all MPPEH would be removed from the MRS which would allow for UU/UE.

Overall Protection of Human Health and the Environment – Alternative 4 would involve the active removal of MPPEH to the maximum exposure depth of the Industrial Receptor (4 feet bgs). The exposure depth is greater than the maximum anticipated depth of MPPEH at the MRS, based on the maximum depth of MDAS found during the RI (14 inches bgs), and ensures overall protection of the Industrial Receptor. No hazards would remain at the MRS following the remedial action. This alternative is protective of human health and meets the criteria.

Compliance with ARARs – This alternative could be performed in a manner that complies with the action-specific ARAR identified in Section 2.3. There is no MC identified for the MRS and chemical-specific ARARs and TBCs do not apply. This alternative would have some impacts to the natural resources at the MRS through the removal of ground cover and small trees to an acceptable height over 2.5 acres of the MRS. The vegetation clearing and removal of small trees for this alternative would not remove the root systems and will not have any potential impact on soil or sediment erosion. Additionally, the target areas would be manually excavated only using hand tools and significant soil disturbance is not anticipated. Adherence to the Ohio sediment and erosion control standards (OAC 1501:15-1-04) is required due to the clearance and disturbance of 2.5 acres of the MRS. Alternative 4 meets this criterion.

Long-Term Effectiveness and Permanence – This alternative involves active removal of surface/subsurface MPPEH and allows for UU/UE. Alternative 4 would result in the complete removal of all MPPEH at the MRS to a depth of 4 feet bgs; therefore, no residual hazards would remain at the MRS. The magnitude of the hazards would be reduced to none, and no residuals or untreated waste would remain. As a result, Alternative 4 would achieve long-term effectiveness and permanence at the MRS.

Reduction of Toxicity, Mobility, or Volume through Treatment – Alternative 4 would result in the complete removal of all MPPEH at the MRS to a depth of 4 feet bgs that allows for UU/UE for the Industrial Receptor. The MPPEH removal depth is greater than the maximum anticipated depth of MPPEH at the MRS (14-inches

bgs). Thus the removal of MPPEH ensures overall protection of the Industrial Receptor. Toxicity associated with MPPEH would be completely removed from the MRS; therefore, this alternative would satisfy the statutory preference for employing treatment as a principal element.

Short-Term Effectiveness – Surface and subsurface removal of MPPEH during Alternative 4 would present a hazard to the field crew handling the MPPEH during removal and disposal operations. This alternative would be effective in protecting human health during the remedial action by implementing DDESB-approved procedures, although some risk is always present when dealing with UXO. The estimated time for completion would be 1 year. The length of time to complete this alternative is short; however, short-term risks to the workers from MPPEH hazards are significant. Short-term effectiveness is considered to be low.

Implementability –This removal action would be technically and administratively feasible to implement. Alternative 4 would require vegetation and trees less than 4 inches in diameter to be removed at the MRS due to the low ground clearance required for the mobile DGM equipment that would be used. Alternative 4 would potentially require the destruction, loss, or degradation of seasonal wetlands along the pond banks. Approvals from the OHARNG would be required for any activities that could impact wetlands or habitats during the nesting season. Any vegetation clearing activities would be conducted outside of the nesting seasons to minimize impacts. Camp Ravenna vegetation removal restrictions for the Northern long-eared bat would also be followed, in that vegetation/trees greater than 3 inches in diameter may not be cut during summer roosting season between April 1 and September 30. Soil disturbance would be minimal since excavation of subsurface anomalies would be conducted by hand-digging only. Storm water controls would be required following vegetation clearing to minimize soil erosion, per the Construction and Development Effluent Guidelines. Site restoration using an RVAAP-approved seed mix would be conducted at exposed soil areas following completion of the remedial action. The alternative's remedial measures would require 1 year to complete with no requirements for O&M.

Cost – The capital costs for Alternative 4 include the development of the planning documents and safety documents ($108,220), mobilization and demobilization of personnel ($32,886), completion of the field activities ($186,153) for a total of capital costs of $451,616). Since this alternative achieves UU/UE, there would be no need for costs to implement LUCs, conduct O&M, or prepare Five-Year Reviews. The capital costs include mobilization/demobilization of staff, vegetation removal, DGM, MPPEH removal, and site restoration. This alternative achieves UU/UE; therefore, CERCLA Five-Year reviews and O&M would not be required. No LUCs and O&M would be required under this alternative. The detailed breakdown of these costs is provided in Appendix B.

State Acceptance – This criterion will be evaluated during incorporation of regulatory review comments into this FS, and for the future submittals of the Proposed Plan and Record of Decision.

Community Acceptance – This criterion will be evaluated when the Proposed Plan is presented to the public for review and comment.

Overall Evaluation – Alternative 4 mitigates potentially remaining MPPEH hazards at the MRS through surface/subsurface removal of MPPEH that achieves UU/UE at the MRS for the Industrial Receptor which is a CERCLA preference. This alternative is technically implementable and administratively feasible and is protective of human health. Alternative 4 would reduce the unacceptable hazard of MPPEH at the MRS such that the likelihood of a receptor encountering MPPEH via direct contact would be negligible. As a result, Alternative 4 meets the RAOs.

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6.0 COMPARATIVE ANALYSIS OF ALTERNATIVES

The detailed analysis performed in Section 5.0 discussed the degree of compliance to the evaluation criteria for each remedial alternative. To aid in identifying and assessing relative strengths and weaknesses across the remedial alternatives, this section provides a comparative analysis of the alternatives so that the most appropriate remedial alternative can be selected. Table 6-1, presented at the end of this section, provides a summary evaluation of each alternative by assigning degrees of acceptability in meeting the nine NCP criteria.

6.1 Comparative Analysis by Criteria

Overall Protection of Human Health and the Environment – Alternative 1 takes no action and is therefore not protective of human health and the environment and does not meet this criterion. Alternatives 2 and 4 are protective of human health and restrict exposure to MPPEH at the MRS through the implementation of removal action and/or LUCs. Alternative 2 is protective through LUCs to prevent human exposure to MPPEH and meets this criterion. Alternative 4 would ensure that surface and subsurface MPPEH is removed to a maximum exposure depth of 4 feet bgs which allows for UU/UE for the Industrial Receptor and meets this criterion.

Compliance with ARARs – There are no chemical-specific and location-specific ARARs identified for Alternatives 1 2, and 4. Because of vegetation clearance and land disturbance associated with Alternative 4, one action-specific ARAR, the Ohio sediment and erosion control standards (OAC 1501:15-1-04), applies. Alternatives 1, 2, and 4 meet this criterion.

Long-Term Effectiveness and Permanence – Alternative 1 takes no action and therefore does not provide long-term effectiveness and permanence. There are different degrees of long-term effectiveness and permanence associated with Alternatives 2 and 4. Because Alternative 2 relies on LUCs with incidental MPPEH removal, its effectiveness and permanence depends on maintaining the educational controls emplaced to modify behavior. LUC Awareness Training is already in place as an interim control for the MRS, and OHARNG is willing to maintain educational controls over the long-term. Alternative 2 does not satisfy the statutory preference for employing treatment as a principal element. Alternative 4 has the greatest degree of effectiveness and permanence since it includes complete removal of MPPEH to the maximum exposure depth of 4 feet bgs and allows UU/UE for the Industrial Receptor. The magnitude of the hazards would be reduced to none by Alternative 4 and no residuals or untreated waste would remain. Alternative 4 satisfies the statutory preference for employing treatment as a principal element.

Reduction of Toxicity, Mobility, and Volume through Treatment – Alternative 1 takes no actions and; therefore, does not provide reduction of toxicity, mobility, or volume through treatment of MPPEH at the MRS. Alternative 2 provides no treatment or removal of MPPEH, other than incidental destruction of MPPEH that might be reported. Therefore, Alternative 2 only partially satisfies the statutory preference for employing treatment as a principal element. Alternative 4 includes treatment through the removal of all MPPEH to the maximum anticipated exposure depth of 4 feet bgs for the Industrial Receptor. Alternative 4 includes treatment of MPPEH by inspection to classify it is either MDAS or MDEH. MDAS is then properly disposed offsite and MDEH destroyed to render it safe (no explosive hazard). Therefore, Alternative 4 provides complete reduction of MPPEH.

Short-Term Effectiveness – Alternative 1 consists of No Action and the explosive hazard posed by the MPPEH is unaltered in the short-term, and Alternative 1 does not have any adverse short-term effects. Under Alternative 2, no removal actions will be conducted at the MRS which eliminates any transportation risks, potential for worker exposure, or short-term risks to the community beyond the baseline conditions. The LUCs to be implemented under Alternative 2 can be quickly established and will further reduce short-term risks by mitigating the potential for exposure to MPPEH at the MRS through behavior controls. The short-term effectiveness for Alternative 2 is considered to be high and is; therefore, acceptable. The short-term effectiveness of Alternative 4 is affected by transportation to and from the MRS and the handling, removal, and disposal (by demolition) operations of MPPEH by the UXO-qualified personnel. The short-term risks to the UXO-qualified personnel under Alternative 4 are greater in comparison to Alternative 2 since it includes complete removal of surface and subsurface MPPEH. Vegetation clearing would be required at the MRS for Alternative 4 and would have potential short-term impacts on the environment due to the disturbance of wetlands and wildlife and nesting habitats. Alternative 4 provides a greater short-term risk to the environment since more aggressive vegetation removal is required for DGM coverage and subsurface MPPEH removal. The short-term risk to the environment for Alternative 4 can be mitigated by limiting the removal of vegetation to what is required to perform the actions. Soil disturbance for Alternative 4 would be minimal since MPPEH removal would be conducted by hand-digging only. In comparison to the other alternatives, the short-term effectiveness of Alternative 4 is lower, but is considered to be acceptable due to the measures that will be taken to mitigate the risks.

Implementability – Although easy to technically implement, Alternative 1 would be the least administratively feasible to implement because the stakeholders are not likely to accept No Action as a remedy. Alternatives 2 and 4 are technically and administratively feasible. Alternative 2 consists of implementing LUCs at the MRS. The OHARNG currently manages LUCs at other areas at Camp Ravenna and MRS-specific LUCs would not be difficult to implement. Alternative 4 would require specialized equipment and personnel to implement. Vegetation clearance would require approval and coordination with the OHARNG to avoid potentially impacting the environment, wetlands, and wildlife and nesting habitats and can affect when Alternative 4 can be implemented. Additionally, Camp Ravenna vegetation removal restrictions for the Northern long-eared bat would need to be followed. These restrictions limit removal of vegetation/trees greater than 3 inches in diameter to a timeframe outside of the summer roosting season (April 1 to September 30). The MPPEH removal action at the MRS under Alternatives 4 is technically feasible to implement, as services and equipment are readily available; however, it is not as easily implemented as Alternatives 1 and 2.

Cost – The progression of present-worth costs from the least expensive to most expensive alternative is as follows:

- Alternative 1 – No Action – $0;
- Alternative 2 – Land Use Controls - $76,672 and Five-Year Reviews of $128,141; and
- Alternative 4 – Surface and Subsurface MPPEH Removal– $451,616.

Alternative 1 does not have capital or O&M costs. The capital costs for Alternative 2 are lowest capital costs compared to other alternatives. The costs associated with Alternative 4 are the highest costs among the alternatives, but allows UU/UE for the Industrial Receptor at the MRS.

State Acceptance - This criterion will be evaluated during incorporation of regulatory review comments into this FS, and for the future submittals of the Proposed Plan and Record of Decision.

Community Acceptance - This criterion will be further evaluated when the Proposed Plan is presented to the public for review and comment.

6.2 Overall Evaluation

To date, all MPPEH found at the Fuze and Booster Quarry MRS has been verified as MDAS (i.e., MD); however, based on the historical use of the MRS as a landfill that reportedly accepted munitions and the amount of MPPEH found during the RI field work, the potential remains for residual MPPEH to be present on the surface and in the subsurface at the MRS. Exposure to MPPEH is a human health concern and the presence of MPPEH at the MRS represents a potential exposure risk to the Industrial Receptor that has a maximum exposure depth of 4 feet bgs. The NCP statutory preference for reduction of toxicity, mobility, or volume through treatment is best achieved with Alternative 4 that allows for UU/UE. Based on the evaluation of NCP criteria Alternative 2 (LUCs) and Alternative 4 (Surface and Subsurface MPPEH Removal [UU/UE]) appear to be acceptable and implementable. The deciding factor will be the lowest cost alternative that meets the RAOs and is also technically and administratively implementable.

Using the comparative analysis of the alternatives presented in this FS, a preferred alternative will be presented to the public in the Proposed Plan for this MRS for review and comment. A remedy will then be selected for this MRS and be presented in the Record of Decision.

107 Table 6-1. Comparison of Alternatives

CERCLA Evaluation Criteria	Remedial Alternatives		
	Alternative 1 No Action	Alternative 2 LUCs	Alternative 4 Surface and Subsurface MPPEH Removal (UU/UE)
Protective of Human Health and Environment	No	Yes	Yes
Complies with ARARs	Yes	Yes	Yes
Effective and Permanent	Lowest	Medium	Highest
Reduces Toxicity, Mobility, or Volume by Treatment	None (no treatment)	Minimal (Incidental treatment)	Complete removal of MPPEH
Short-Term Effectiveness	Lowest	Medium	Highest
Implementable	Highest ease to implement	Easily implementable	Most difficult to implement
Costs (does not include 5-year reviews)			
Capital	$0	$20,445	$451,616
O&M (discounted)	$0	$56,227	$0
Total Present Worth	$0	$76,672	$451,616
Costs for 5-Year Reviews			
5-Year Reviews and Incidental Destruction of MDEH (Periodic Costs for 30 years, discounted)	$0	$128,141	$0

108 *ARAR denotes applicable or relevant and appropriate requirement.*
109 *LUC denotes Land Use Control*
110 *MPPEH denotes material potentially presenting and explosive hazard*
111 *O&M Operation and Maintenance*
112 *UU/UE denotes Unrestricted Use/Unrestricted Exposure*
113
114

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Appendix A
Institutional Analysis

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Facility-Wide Institutional Analysis for the Former Ravenna Army Ammunition Plant Portage and Trumbull Counties, Ohio

Contract No. W912DR-15-D-0016
Delivery Order No. 0001

Prepared for:

US Army Corps of Engineers

North Atlantic Division, Baltimore District
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List of Tables

ARNG	Army National Guard
Camp Ravenna	Camp Ravenna Joint Military Training Center
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
DDESB	DoD Explosives Safety Board
DERP	Defense Environmental Restoration Program
DID	Data Item Description
DO	Delivery Order
DoD	Department of Defense
EP	Engineer Pamphlet
FS	Feasibility Study
HGL	HydroGeoLogic, Inc.
IA	Institutional Analysis
LUC	land use control
MMRP	Military Munitions Response Program
MPPEH	munitions potentially presenting and explosive hazard
MRS	munitions response site
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
OE	ordnance and explosives
Ohio EPA	Ohio Environmental Protection Agency
OHARNG	Ohio Army National Guard
RVAAP	Ravenna Army Ammunition Plant
SARA	Superfund Amendments and Reauthorization Act
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
USP&FO	U.S. Property and Fiscal Officer
UXO	unexploded ordnance

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1.0 INTRODUCTION

This Institutional Analysis (IA) report was prepared by HydroGeoLogic, Inc. (HGL) for the U.S. Army Corps of Engineers (USACE), Baltimore District, under Military Munitions Response Program (MMRP) Contract No. W912DR-15-D-0016, Delivery Order (DO) No. 0001. This document has been prepared in accordance with *Final United States Army Military Munitions Response Program: Munitions Response Remedial Investigation/Feasibility Study* [FS] *Guidance* (U.S. Army, 2009); USACE Engineer Pamphlet (EP) 1110-1-24, *Establishing and Maintaining Institutional Controls for Ordnance and Explosives (OE) Projects* (USACE, 2000), U.S. Environmental Protection Agency (USEPA) guidance document USEPA-540-R-09-001, *Institutional Controls: A Guide to Planning, Implementing, Maintaining, and Enforcing Institutional Controls at Contaminated Sites* (USEPA, 2012), and Data Item Description (DID) MR-100, "Institutional Analysis and Institutional Control Plan." The purpose of the IA report is to identify the government agencies necessary to support the response action to be implemented at the Munitions Response Sites (MRSs) addressed by this DO at the former Ravenna Army Ammunition Plant (RVAAP) in Portage and Trumbull Counties, Ohio. This document is intended to be an appendix to each MRS-specific FS. Please refer to the appropriate FS for additional background information.

1.1 Land Use Controls Evaluation

The typical strategies for addressing the presence of material potentially presenting an explosive hazard (MPPEH) on an MRS are physical removals and land use controls (LUCs). LUCs are implemented to manage any residual MPPEH hazard remaining at a MRS. LUCs can also be implemented as a stand-alone response without a physical removal.

LUCs consist of various legal mechanisms, educational and engineering control measures, and construction support actions to minimize the potential MPPEH or other hazards for human receptors at an MRS. Instead of eliminating the MPPEH hazard, a LUC remedial action relies on behavior modification and access control strategies to reduce explosive safety hazards. There are four categories of LUCs, as described in USEPA-540-R-09-001:

- Proprietary controls are generally created pursuant to state and tribal law to prohibit or restrict activities that may pose a safety hazard. These generally consist of easements and covenants.
- Governmental controls impose restrictions on land use or resource use, using the authority of a government entity. Typical examples of governmental controls include zoning, building codes, and groundwater use regulations.
- Enforcement and permit tools with LUC components are legal tools, such as administrative orders, permits, Federal Facility Agreements, and Consent Decrees that limit certain site activities or require the performance of specific activities (e.g., to monitor and report on LUCs effectiveness). They may be issued unilaterally or negotiated.
- Informational devices provide information or notification to local communities that residual or contained contamination remains. Typical informational devices include state registries of contaminated MRSs, notices in deeds, and tracking systems.

To effectively manage long-term residual hazards from MPPEH, USACE seeks and encourages meaningful stakeholder involvement. Coordination with the Army National Guard (ARNG), Ohio Army National Guard (OHARNG), and Ohio Environmental Protection Agency (Ohio EPA) is essential to identifying MRS-specific objectives for an effective LUC program. This coordination includes conducting an IA. The IA process provides the opportunity to obtain information from and to coordinate with government agencies and other stakeholders in developing and implementing an MRS-specific LUC program. The objectives of an IA are to illustrate the opportunities that exist to implement a LUC program at a specific MRS; identify government agencies having jurisdiction over the MRS; and assess the appropriateness, capability, and willingness of government agencies to assert their control over the MRS. This document has been designed to encompass all MRSs addressed under this DO; therefore, each entity's capability and willingness will not be described in an MRS-specific manner.

1.2 Purpose

The purpose of this IA is to determine whether government agencies and/or non-government entities have jurisdiction over the MRS to implement and maintain LUCs. Although LUCs are a viable alternative for minimizing exposure to potential MPPEH, those entities involved in establishing and maintaining LUCs must be capable and willing to do so for the LUCs to be protective. The IA will aid in the evaluation of LUCs that are a component of the alternatives presented in the FS. More specifically, the objectives of this analysis are as follows:

- Document which agencies or entities have jurisdiction over any affected lands within an MRS;
- Assess the authority, capability, and willingness of each agency or entity to assert control that would protect the community from potential MPPEH hazards;
- Document the obligations, if any, of each agency or entity to protect the surrounding community from associated explosive hazards under the law; and
- Document any interim controls or existing LUCs currently in place at each MRS for the protection of human health from potential MPPEH hazards.

Government agencies and other stakeholders that will be required to support short- and long-term LUCs proposed for the MRSs are described and evaluated in this IA report.

1.3 Hazard Review

This IA has been designed to address the institutional support needs of several MRSs associated with the former RVAAP. The MRSs considered during development of this document are listed in Table 1.1 below. The hazards and recommendations associated with each MRS are located in Sections 1.2 and 1.3 of each MRS specific FS.

Table 1.1
Munitions Response Sites Included

MRS	Identification
Ramsdell Quarry Landfill	RVAAP-001-R-01
Erie Burning Grounds	RVAAP-002-R-01
Open Demolition Area #2	RVAAP-004-R-01
Fuze and Booster Quarry	RVAAP-016-R-01
40mm Firing Range	RVAAP-032-R-01
Block D Igloo	RVAAP-060-R-01
Group 8 MRS	RVAAP-063-R-01

1.4 Regulatory Background

Existing regulations allow for and/or clarify the implementation of LUCs and the performance of an IA. The regulatory authorities governing the establishment and maintenance of LUCs during munitions response actions include the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA); the National Oil and Hazardous Substances Pollution Contingency Plan (NCP); and the Defense Environmental Restoration Program (DERP). These regulations are summarized in Table 1.2 below.

Table 1.2
Summary of Regulatory Background

Regulation	Year Established	Description
Comprehensive Environmental Responses, Compensation and Liability Act (CERCLA)	1980	Created the framework for funding and remediation of abandoned or uncontrolled hazardous waste sites.
Superfund Amendments and Reauthorization Act (SARA), (Section 211, Chapter 160, Environmental Restoration)	1986 Amendment to CERCLA	Established the Defense Environmental Restoration Program (DERP) to "correct environmental damage" that may endanger human health and the environment.
National Oil and Hazardous Substances Pollution Contingency Plan (NCP), (40 Code of Federal Regulations [CFR] Part 300)	Established through the Clean Water Act in 1972	Further outlined procedures for developing, evaluating, and implementing appropriate response actions based on stakeholder input. The March 1990 revision is the latest version of the NCP. Paragraph 300.120(c) identifies the Department of Defense (DoD) as the removal response authority with respect to incidents involving DoD weapons and munitions.
National Defense Authorization Act, (Public Law 107-107)	2002 Amendment to DERP	Created the Military Munitions Response Program (MMRP). Under MMRP, DoD conducts munitions response actions per CERCLA, the NCP, and applicable federal and state laws. DoD considers reasonably anticipated future land use in the design and implementation of response actions. Involvement of local and state government, and other authorities, is encouraged within the munitions response process.

1.5 Institutional Methodology

This document constitutes the IA for the MRSs identified in Table 1.1. Five elements are considered when assessing the ability of a local, county, or state agency to assist in the implementation or monitoring of a proposed LUC program. These five elements are as follows:

- Jurisdiction – The jurisdiction is the territorial range of authority and is generally defined by geographic boundaries within the city, county, or state. Federal, state, and local government agencies may have jurisdiction within the MRS. The laws governing the existence of the specific agency will convey this jurisdiction. In some areas, several agencies may be involved, depending on the type of LUC or what specific aspect of a LUC is being contemplated.
- Authority – The authority of an institution is the nature and extent of controls available to the institution and its legal ability to enforce these controls in each jurisdiction. Key questions that must be asked regarding the authority exercised by a government agency are listed below.
  - What are the limits of the agency's authority?
  - What is the origin of the agency's authority?
  - How much control is exercised by the agency?
  - Does the agency have enforcement authority?
- Mission – The specific mission of the agency is critical to its ability to implement, enforce, or maintain an LUC program.
- Capability – Even if an agency has the jurisdiction, authority, and mission to be involved in an LUC program, if it does not have the capability, it cannot be an effective partner. In the case of local government agencies, the capabilities may be unique and are often a reflection of the desires of the local community. The capabilities of a government or private agency can be augmented; however, this may be subject to fiscal law or budgetary constraints.
- Desire – The desire of a government or private agency to participate in an LUC program is critical to its success. The effectiveness of LUCs is increased when local officials are convinced that participation in an LUC program is in their best interest. Resources in the form of funding for the agency's implementation efforts can help the agency overcome its initial hesitancy to become involved.

1.6 Institutional Selection

The former RVAAP, now known as the Camp Ravenna Joint Military Training Center (Camp Ravenna), is located in northeastern Ohio within Portage and Trumbull Counties. Camp Ravenna is approximately 3 miles east/northeast of the City of Ravenna and 1 mile north/northwest of the City of Newton Falls. The facility, approximately 11 miles long and 3.5 miles wide, is bounded by the Norfolk Southern Railroad to the north; State Route 5, the Michael J. Kirwan Reservoir, and the CSX System Railroad to the south; State Route 534 to the east; and Garret, McCormick, and Berry Roads to the west. In addition, the facility is surrounded by the communities of Windham, Garrettsville, Charlestown, and Wayland.

Administrative accountability for the entire 21,683-acre facility was transferred in 2013 to the U.S. Property and Fiscal Officer (USP&FO) for Ohio (the property owner), which subsequently licensed the property to

OHARNG to use for military training. The owner of Camp Ravenna and the MRSs included in this IA is the USP&FO for Ohio. The RVAAP restoration program involves cleanup of former production/operational areas throughout the facility related to former munitions plant activities.

Institutions were selected for this IA based on their potential ability to have jurisdiction and authority to implement and maintain LUCs within the Camp Ravenna facility, or their having a specific mission to protect the public from potential MPPEH hazards. The institutions selected for evaluation are the USP&FO, OHARNG, ARNG, Ohio EPA, and USACE.

A summary of LUC options available for the MRSs addressed under this DO is provided in Section 2.0. During preparation of the IA, USP&FO, OHARNG, ARNG, Ohio EPA and USACE provided information to address items/questions presented in Section 3.0. Representatives of these stakeholders were interviewed by telephone or contacted by email to obtain their perspective and feedback on existing and potential future LUCs. The current and future activities anticipated for the applicable MRSs are presented in Table 1.3.

Table 1.3
MRS Current and Future Land Use

MRS	Current Land Use	Future Land Use
Ramsdell Quarry Landfill	Maintenance, natural resource management, and sampling	No changes anticipated; however, future military training possible.
Erie Burning Grounds	Maintenance, natural resource management, and sampling	Fire suppression
Open Demolition Area #2	Maintenance, natural resource management, and sampling	No changes anticipated; however, future military training possible.
Fuze and Booster Quarry	Maintenance, natural resource management, and sampling	Military training
40mm Firing Range	Maintenance, natural resource management, and sampling	No changes anticipated; however, future military training possible.
Block D Igloo	Military training, maintenance, natural resource management, and sampling	No changes anticipated; however, future military training possible.
Group 8 MRS	Maintenance, natural resource management, and sampling	No changes anticipated; however, future military training possible.

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2.0 LAND USE CONTROLS

This section summarizes LUC options available for the applicable MRSs. LUCs protect property owners, and other workers or personnel, from potential hazards by warning them of their existence and/or limiting access to, or use of, the MRS. LUCs can include legal mechanisms, engineering controls, and educational controls. However, the effectiveness of LUCs depends on the support, involvement, and willingness of local agencies, stakeholders, and landowners to enforce and maintain them. The following subsections describe types of LUCs in detail; however, not all LUCs are appropriate for the MRSs at Camp Ravenna. No LUCs are currently enforced at the MRSs, but interim controls have been established while these MRSs are being investigated. Table 2.1 presents the interim controls previously established and the LUC options that could be implemented at the Fuze and Booster Quarry MRS. Table 4.1 in Section 4.0 presents the current and potential future controls for each MRS addressed under this DO.

Table 2.1
Interim Controls Previously Established and LUC Options

MRS	Interim Controls Currently in Place		Land Use Control Options
	Educational Controls	Engineering Controls	
Fuze and Booster Quarry	Annual training for all Camp Ravenna employees	Siebert Stakes and Signage	Educational Controls to include the 3Rs of UXO safety
	Contractor training as needed upon worker entry to the MRS	Gates at entrance road	Engineering Controls
	National Guard training as needed upon trainee in-brief to Camp Ravenna	None	Future Remedial Action

FSs for the other MRSs will be submitted separately for review and will also include this IA document.

2.1 Legal Mechanisms

Legal mechanisms limit or control the land use and/or activities that can occur on a property through actions such as deed restrictions, covenants, zoning, permits, and activity requirements/restrictions.

2.1.1 Restrictive Covenants

Restrictive covenants are clauses in property deeds that contractually limit how owners can use the property. Private restrictive covenants are different than zoning ordinances. If the restrictive covenant forbids a use permitted by a zoning ordinance, the restrictive covenant would operate to encumber the property to prohibit the restricted use(s). On the other hand, if the zoning ordinance is more restrictive than the restrictive covenant, the zoning ordinance would take precedence. Restrictive covenants are not applicable to these MRSs as they are within a federal facility. Deed restrictions or covenants will not be put into place at Camp Ravenna, as the landowner is the USP&FO for Ohio.

2.1.2 Zoning

Zoning consists of land use or activity restrictions within a specified area as established by a governmental entity (usually a local government such as a municipality or county). The zoning requirements can specify

the type of land use (e.g., rural, residential, business, etc.) and can provide specific requirements such as building sizes, setbacks, and street and parking provisions.

2.1.3 Dig Permit System

A dig permit system similar to that for a building permit may be established. A dig permit system can document who is performing the work and the extent and purpose of the digging activity. The permit may require workers to review and sign off on information provided to them about the potential for encountering MPPEH and to comply with established protocols for soil/sediment disturbance activities in potential MPPEH areas. Implementing a dig permit system can require establishing an authority to administer and enforce the permits. A dig permit system requires establishing rules on the type and extent of digging that would require obtaining a permit. Costs for the dig permit system would include initial program setup and then annual administration. There are no currently funded construction projects for these MRSs. Camp Ravenna manages digging activities within existing procedures and does not support the implementation of an MPPEH specific dig permit system. Therefore, a separate dig permit system specific to these MRSs is not applicable.

2.1.4 Contractor Control Policies

Contractor control policies are written procedures that dictate how contractors who work at an MRS with LUCs will be trained and monitored. They are generally MRS-specific and tailored to the potential hazards present, as well as to the ability of the governing authorities to perform the monitoring. Camp Ravenna manages contractors that access these MRSs within existing procedures and does not support the implementation of additional MPPEH specific control policies; therefore, contractor control policies specific to these MRSs are not applicable.

2.1.5 Construction Support

Construction support is an effective method to allow site activities to continue safely in areas with potential MPPEH hazards. Construction support can be accomplished in one of two ways: stand-by or on call. Stand-by support is having unexploded ordnance (UXO)-qualified personnel on site during soil/sediment disturbance activities. The UXO personnel would be available to immediately identify any unknown items recovered and make appropriate disposition decisions for those items.

On-call support does not require stationing qualified UXO personnel on site for immediate access. On-call support can be off-site Explosive Ordnance Disposal responders or a UXO contractor available for response as needed. This option includes a site worker MPPEH safety training element, is cost effective, and is deemed appropriate for soil/sediment disturbance activities taking place at the MRSs.

Construction support activities are available to Camp Ravenna to support funded construction projects facility-wide. Therefore, there is no reason to create a construction support activity on an MRS-specific basis. Additionally, there are no currently funded construction projects for the MRSs included in this IA; therefore, no construction support or on-call support is recommended as a LUC.

2.1.6 Monitoring

Monitoring at the MRS is a legal mechanism process option that would include visual and physical inspections of the conditions at the MRS and engineered remedial action components, as applicable, and can detect physical changes (e.g., missing signs, unwanted/overgrown vegetation, etc.) that may ultimately lead to the failure or unsatisfactory performance of that component. Repairs and/or revised maintenance activities can be implemented as a result of these inspections. Monitoring would determine the need for repairs and/or

replacement of any engineering controls. Exposure hours monitoring is not administratively feasible for occupational hazards to trainees accessing the MRS; however, monitoring of any engineering controls implemented, would be conducted. The appropriate frequency for monitoring would be established to ensure the effectiveness of the remedial alternative and would result in O&M costs until UU/UE (i.e. negligible MPPEH exposure) is achieved. If applicable, monitoring plans are hazard specific and monitoring occurs as frequently as necessary based on the hazards and MRS characteristics. Examples of monitoring activities include UXO qualified escorts periodically conducting enhanced visual surveys. These activities ensure early identification and response for any material documented as an explosive hazard (MDEH). Exposure hours monitoring is not administratively feasible for occupational hazards to trainees accessing the MRS; however, monitoring will be applied for any LUCs implemented for the MRSs included in this IA.

2.2 Engineering Controls

Engineering controls are physical structures that warn of hazards or prevent access to an MRS. The most probable structures for implementation at the former RVAAP MRSs are fencing, signage, and land covers.

2.2.1 Fencing

Fences are used to restrict public access to an MRS that contains a potential public hazard. Fences are appropriate for areas where MPPEH may be present and where public access would result in potential exposures. Fences require inspection, maintenance, and repair to remain effective. Based on the Camp Ravenna mission to use the MRSs for National Guard training; no fencing of the MRSs is preferred. However, the use of fencing will be evaluated for each MRS dependent upon identified hazards. The use of fencing will be applied on an MRS-specific basis.

2.2.2 Signage

Warning signs can be used to notify and inform the public of a potential hazard on a MRS. Such signs would state the nature of the potential MPPEH hazard, how to avoid the hazard, and whom to contact for additional information. Warning signs may be used in conjunction with fencing or may be used as a stand-alone measure where fencing is not an option. Signage may be applicable to an MRS and will be recommended on an MRS-specific basis.

2.2.3 Seibert Stakes

Seibert stakes are posts with red and yellow reflector markings indicating the boundary of a specific area. The stakes are typically used within military training areas to mark the boundaries of sensitive, hazardous, or contaminated areas that are off limits to training or maneuver activities. Siebert stakes have been installed on some of the included MRSs and are currently in use as an interim control. Continued use of Siebert stakes as a future LUC will be evaluated on an MRS-specific basis.

2.2.4 Security Patrols

The regular patrolling of an MRS by a security officer can ensure that unauthorized personnel do not enter an area with explosive hazards. This control can be implemented alone or in conjunction with other LUCs to ensure that all established LUCs are enforced. As the entire Camp Ravenna facility is regularly patrolled, no additional MRS-specific security patrols are applicable to the MRSs included in this IA.

2.3 Educational Controls

Educational controls can include programs geared toward notification of existing conditions, existing engineering controls, and potential hazards to visitors, Camp Ravenna personnel, contractors, and utility workers. Examples of educational controls include public information meetings, printed materials (e.g., information displays and flyers), training for potential receptors (e.g., LUC awareness, recognition, and reporting procedures), and websites to inform property users of the potential presence of MPPEH, stressing the importance of the 3Rs—recognize, retreat, and report—of unexploded ordnance safety. Educational controls can be implemented to provide informational materials on potential MPPEH recognition, avoidance, and encounter protocols. The use of educational controls (annual training for employees, National Guard trainee in-briefings, and contractors/site workers trained before they access the MRS) is already being implemented by Camp Ravenna; however, the 3Rs of unexploded ordnance safety are currently not included in the training. Continued use of educational controls with the addition of the components of the 3R's of explosive safety, will be evaluated on an MRS-specific basis.

3.0 INSTITUTIONAL SUMMARIES

The following subsections describe the jurisdiction, authority, mission, and potential role in a LUC program of each institution selected for analysis.

3.1 U.S. Property and Fiscal Officer

A USP&FO, as established in Title 32 U.S. Code 708, is a "qualified commissioned officer of the National Guard of that jurisdiction…". A USP&FO is selected by the governor of each state, the Commonwealth of Puerto Rico, Guam, and the U.S. Virgin Islands. The USP&FO is responsible for any receipt or return of funds and/or National Guard property under the jurisdiction of the USP&FO's state. The ownership of Camp Ravenna was transferred to the USP&FO for Ohio through several transactions between 1999 to 2013. The USP&FO then licensed the property to OHARNG for use as a military training facility. Through this transaction, the USP&FO has delegated all LUCs implementation authority to OHARNG. Additional information regarding the USP&FO is provided in Table 3.1.

Table 3.1
U.S. Property and Fiscal Office Institutional Summary

Origin of Institution	Title 32 U.S. Code 708 and DoD Instruction 1200.18
Basis of Authority	The authority of USP&FO is recognized by the State of Ohio under Title 32 U.S. Code 708 and DoD Instruction 1200.18
Sunset Provisions	None
Geographic Jurisdiction	The geographic jurisdiction of the Ohio USP&FO includes any ARNG property under their administrative power within the State of Ohio. The USP&FO has geographic jurisdiction for the 21,683 acres within Camp Ravenna under License No. DACA27-3-06-013.
Public Safety Function	None
Land Use Controls	Under License No. DACA27-3-06-013, USP&FO delegated to the State of Ohio/ OHARNG the authority to comply with applicable environmental protection laws, which include LUCs.
Financial Capability	None
Desire to Participate	Not applicable
Constraints to Institutional Effectiveness	Under the provisions of the Ravenna License No. DACA27-3-06-013 and the National Guard Regulation 130-6, the OHARNG has financial capability and authority for LUCs.

3.2 Ohio Army National Guard at the Camp Ravenna Joint Military Training Center

After munitions production at RVAAP ceased, the accountability for the property was transferred to the Ohio USP&FO in several transfers from 1999 to 2013. The property was renamed "Camp Ravenna Joint Military Training Center" and is known as Camp Ravenna. Camp Ravenna is licensed to OHARNG for use as a military training facility.

OHARNG was established through the Militia Law of 1803 as one of the first acts of Ohio's statehood. OHARNG is comprised of soldiers who train bimonthly and otherwise lead civilian lives until they are called to serve (OHARNG, 2016). OHARNG is a state militia under the control of the Governor of Ohio until called to federal service by the President of the United States. The authority of the OHARNG to implement, maintain, and enforce LUCs at Camp Ravenna has been established under License No. DACA27-3-06-013. Additionally, OHARNG's use of Camp Ravenna incentivizes it to provide a safe working and training environment for OHARNG personnel and trainees.

Access to Camp Ravenna is limited; however, once authorized visitors are on the property, physical access to the MRSs is unrestricted. Additional information regarding OHARNG at Camp Ravenna is provided in Table 3.2.

Table 3.2
Ohio Army National Guard Institutional Summary

Origin of Institution	The Northwest Territory militia was established as OHARNG, an Ohio state militia, in 1803.
Basis of Authority	The USP&FO for Ohio has delegated all LUC implementation authority to OHARNG under License No. DACA27-3-06-013.
Sunset Provisions	None
Geographic Jurisdiction	The geographic jurisdiction of OHARNG is limited to the State of Ohio unless the entity is called upon for federal service by the President of the United States. OHARNG has jurisdiction over multiple military training facilities, including Camp Ravenna.
Public Safety Function	OHARNG has public safety functions including: management of safety procedures on Camp Ravenna; the authority to implement LUCs at Camp Ravenna; and the interim controls established to protect personnel on Camp Ravenna.
Land Use Controls	OHARNG is willing to implement, maintain, and enforce the LUCs listed in Table 4.1., once ARNG provides funding and approval.
Financial Capability	Funding for LUCs at Camp Ravenna is provided through the Installation Restoration Program, established under DERP and applicable for all ARNG facilities.
Desire to Participate	OHARNG is willing to implement the LUCs as summarized in Table 4.1, once ARNG provides approval.
Constraints to Institutional Effectiveness	OHARNG does not have financial capability to implement LUCs at Camp Ravenna. ARNG (See Section 3.3) has the financial capability to implement LUCs. These two entities work in coordination, as such, OHARNG must obtain approval from ARNG for implementation of LUCs.

3.3 Army National Guard

In 1636, ARNG was designated as the first North American militia group to protect colonists from hostile attacks. The militia was established through the Massachusetts Bay Colony's General Court and has been recognized and preserved by the Militia Acts of 1792 and 1903, and by the National Defense Act of 1916 (ARNG, 2016). This entity is characterized by a dual federal and state status unique to ARNG. ARNG members work primarily in their home states preparing for federal response actions as called upon by the

President of the United States. ARNG is not the same agency as OHARNG; ARNG is a federal militia established to respond to national emergencies or wartime needs in coordination with the U.S. Military.

The OHARNG and ARNG work in coordination; therefore, through the OHARNG License No. DACA27-3-06-013, the ARNG has authority to effectively maintain and enforce LUCs at Camp Ravenna. However, the ARNG has delegated this authority to the OHARNG for specific purposes of LUC enforcement at Camp Ravenna. Additional information regarding ARNG is provided in Table 3.3.

Table 3.3
Army National Guard Institutional Summary

Origin of Institution	ARNG was established in December 1636 as the first North American militia group through the Massachusetts Bay Colony's General Court. The Militia Acts of 1792 and 1903, and the National Defense Act of 1916 recognized the militia as a national defense group known today as ARNG.
Basis of Authority	The authority of ARNG is based in the U.S. Government. Specific authority is assigned to ARNG for Camp Ravenna under the following: Ravenna License No. DACA27-3-06-013 to the OHARNG and National Guard Regulation 130-6
Sunset Provisions	None
Geographic Jurisdiction	The geographic jurisdiction of ARNG includes the United States and its territories for services as called upon by the President of the United States.
Public Safety Function	The ARNG provides a public safety service by providing funding and approval for LUCs at Camp Ravenna.
Land Use Controls	The OHARNG and the ARNG has authority to implement, maintain, and enforce LUCs at Camp Ravenna through License No. DACA27-3-06-013.
Financial Capability	ARNG receives funding from the U.S. Government and has the financial capability to maintain and enforce LUCs throughout the property.
Desire to Participate	ARNG is willing to implement the LUCs as summarized in Table 4.1.
Constraints to Institutional Effectiveness	ARNG provides funding for LUCs at Camp Ravenna. The ability to provide funding is affected by budget changes over time, limiting funding for specific Camp Ravenna projects.

3.4 Ohio Environmental Protection Agency

Ohio EPA was established by the State of Ohio in 1972 by merging several environmentally focused state departments and was tasked with providing clean air and water to the people of Ohio. Ohio EPA establishes and enforces air, water, and waste management standards throughout the State of Ohio. Ohio EPA also provides public educational and pollution prevention programs to minimize the effects of pollution (Ohio EPA, 2016).

Ohio EPA has regulatory authority in the geographical area of Camp Ravenna and has coordinated with the USACE, Baltimore District, and OHARNG to ensure that appropriate LUCs will be implemented at the RVAAP MRSs. The ability of Ohio EPA to monitor maintenance needs and enforce the LUCs at Camp Ravenna would depend on its willingness to maintain communications with Camp Ravenna personnel. Additional information regarding Ohio EPA is provided in Table 3.4.

Table 3.4
Ohio Environmental Protection Agency Institutional Summary

Origin of Institution	Ohio EPA was established on October 23, 1972.
Basis of Authority	The regulatory authority of Ohio EPA to establish and enforce environmentally protective regulations is granted by the State of Ohio. Although Camp Ravenna is a federally owned property the Ohio EPA has regulatory authority and will continue to coordinate with OHARNG (by review and concurrence to documents) to ensure appropriate LUCs are established.
Sunset Provisions	None
Geographic Jurisdiction	The geographic regulatory authority for Ohio EPA includes the State of Ohio.
Public Safety Function	The Ohio EPA has the regulatory authority to establish and enforce laws and regulations that protect against human health and environmental concerns. The public safety function of the Ohio EPA at Camp Ravenna is accomplished through the coordination with Camp Ravenna (by review and concurrence to documents) to establish appropriate LUCs.
Land Use Controls	As a regulatory authority, Ohio EPA may review and concur with the LUCs presented in the FS, Proposed Plan, and Decision Documents.
Financial Capability	None
Desire to Participate	Ohio EPA is willing to provide review and concurrence to LUCs proposed by ARNG.
Constraints to Institutional Effectiveness	As a stakeholder, Ohio EPA may participate in the development of LUCs for the Camp Ravenna MRSs and provide review and concurrence. However, Ohio EPA is unable to provide funding for LUC implementation and maintenance.

3.5 U.S. Army Corps of Engineers

USACE provides technical and project management support on environmental and MMRP projects at Camp Ravenna and has jurisdiction over munitions response work at the MRSs. The USACE, Baltimore District, works in coordination with the USACE, Louisville District, ARNG, and OHARNG/Camp Ravenna. USACE Baltimore District provides the technical expertise and serves as a technical resource for MMRP guidance and DoD guidance applicable to a munitions response site. Additional information regarding USACE is provided in Table 3.5.

Table 3.5
U.S. Army Corps of Engineers Institutional Summary

Origin of Institution	USACE was established in 1775 to provide construction and engineering support to the U.S. Government. In the 1880s, Congress also provided USACE with authority over dumping and dredging in harbors and waterways. With the formation of DERP in 1983, USACE began providing technical and project management support on environmental and MMRP projects.
Basis of Authority	USACE conducts munitions response actions under CERCLA, as amended by SARA, Executive Orders 12580 and 13016, and the safety requirements of the DoD Explosives Safety Board (DDESB). USACE has project-specific management and technical oversight authority on Army MMRP projects.
Sunset Provisions	None
Geographic Jurisdiction	USACE has nine regional divisions that include all of the U.S., the Pacific, Europe, the Middle East, and Afghanistan. USACE provides MMRP project oversight for Camp Ravenna through USACE, Baltimore District, technical staff.
Public Safety Function	USACE executes contracts for FSs, Proposed Plans, and Decision Documents to identify appropriate LUCs for MRSs. Additionally, USACE ensures these LUCs are implemented by the landowners and that they are protective of human health and the environment.
Land Use Controls	As technical advisor to the Army, USACE influences the development and selection of LUCs and ensures the implementation of the chosen controls.
Financial Capability	USACE could administer an LUC design or maintenance/oversight contract if programmed and funded by DoD or ARNG.
Desire to Participate	USACE is willing to support ARNG/Camp Ravenna in the development of an LUC program.
Constraints to Institutional Effectiveness	USACE coordinates with OHARNG personnel for establishing LUCs; however, USACE does not have the ability to directly implement, maintain, or enforce LUCs once established. USACE only acts in a design/development role at the will of the entities discussed above.

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4.0 EVALUATION OF EXISTING AND POTENTIAL CONTROLS

This section provides an evaluation of existing and potential LUCs discussed in Section 2.0 using the institutional information presented in Section 3.0.

4.1 Evaluation of Existing Controls

Camp Ravenna is fenced at the perimeter (though this fencing was not established as a LUC); however, within the facility access to the MRSs is unrestricted. Interim controls have been established at some of the MRSs addressed in this IA. The purpose of the interim controls is to temporarily reduce hazards while long-term solutions are identified, evaluated, and established. These temporary measures include reflective Siebert stakes and signs indicating that there are hazards within the MRS. Table 4.1 lists the interim controls present at each MRS addressed by this IA.

Another interim control currently used is educational controls in the form of training (LUC Awareness Training) conducted with National Guard trainees, Camp Ravenna full-time workers, and other contractors or visitors to the MRSs. This training provides an overview of the Property Management Plan and the procedures for recognizing and avoiding munitions.

The LUC Awareness Training currently conducted as an interim control (See Table 4.1, "Educational Controls") indicates that the explosive hazards and potential MC risks are effectively mitigated by the interim controls currently in place at the Fuze and Booster Quarry MRS. Based on the effectiveness of the interim controls and the future land use, it is anticipated that the potential controls will continue to effectively mitigate explosive hazards. However, the addition of the 3Rs of UXO safety to the current educational program may provide additional knowledge on the specific type of contamination anticipated. The OHARNG personnel are trained to deal with MPPEH avoidance and reporting procedures as a part of the LUC Awareness Training. The OHARNG supports the current and potential controls listed in Table 4.1 and the controls will provide adequate protection of human health and the environment.

4.2 Evaluation of Potential Controls

OHARNG has the authority to implement, maintain, and monitor LUCs within the MRSs. Therefore, potential future controls for the MRSs were discussed with representatives from OHARNG and the Camp Ravenna Environmental Office. Based on these conversations, it was determined that the LUCs described in Table 4.1 are appropriate for the specific hazards present in each MRS. The ongoing awareness training conducted per the Property Management Plan should continue for all MRSs to ensure that the receptors identified in the FS for each MRS are aware of the controls in place. It was determined that the LUCs listed in Table 4.1 are supported by OHARNG and ARNG for implementation at the MRS as indicated.

Table 4.1
Interim and Potential LUCs

MRS	Interim Controls Currently in Place		Potential Land Use Controls
	Educational Controls	Engineering Controls	
Ramsdell Quarry Landfill	· Annual training for all Camp Ravenna employees · Contractor training as needed upon worker entry to the MRS · National Guard training as needed upon trainee in-brief to Camp Ravenna	Siebert Stakes and Signage	Educational Controls
Fuze and Booster Quarry		**Siebert Stakes and Signage**	**Educational Controls**
Erie Burning Grounds		Siebert Stakes and Signage	Educational Controls
40mm Firing Range		Siebert Stakes and Signage (at former impact area only)	Educational Controls and Engineering Controls (Siebert stakes and signage)
Open Demolition Area #2		Gate at entrance road, Siebert Stakes, and Signage (Siebert Stakes only along the west and south perimeter)	Educational Controls and Engineering Controls
Block D Igloo		None	Educational Controls and Engineering Controls
Group 8 MRS		Siebert Stakes and Signage	Educational Controls and Engineering Controls

Note: **Bold/Highlighted text identifies the applicable MRS FS to which this IA is appended.**

FSs for the other MRSs will be submitted separately for review and will also include this IA document.

5.0 REFERENCES

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Appendix B
Feasibility Study Cost Summary Tables

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Table B-1
Fuze and Booster Quarry MRS
Alternative 2: Land Use Controls

ITEM	UNIT	UNIT COST	QUANTITY	TOTAL
CAPITAL COSTS				
Reporting/Workplans				
Land Use Control Implementation Plan	Lump Sum	$9,758	1	$9,758
Subtotal				**$9,758**
Institutional Controls				
LUCs Awareness Training	Lump Sum	$3,269	1	$3,269
Educational Controls-Briefing Handouts	Lump Sum	$1,788	1	$1,788
Subtotal				**$5,057**
	SUBTOTAL			**$14,815**
	SUPERVISION AND ADMIN @ 8%			$1,185
	CONTINGENCY @ 30%			$4,444
	TOTAL CAPITAL COSTS			**$20,445**
ANNUAL O&M COSTS				
Institutional Controls Maintenance				
LUC Awareness Training	Lump Sum	$2,795	1	$2,795
Subtotal				**$2,795**
	SUBTOTAL (ANNUALLY)			**$2,795**
	SUPERVISION AND ADMIN @ 8%			$224
	CONTINGENCY @ 30%			$839
	TOTAL ANNUAL O&M COSTS			**$3,858**
	TOTAL O&M COSTS (30 Years)			**$84,926**
	O&M PRESENT WORTH (2.8%)			**$56,227**
TOTAL ALTERNATIVE COST (Capital + O&M Present Worth)				**$76,672**
PERIODIC COSTS				
Monitoring and Five Year Review Reports (Years 5, 10, 15, 20, 25, 30)				
Site Visit and Enhanced Visual Survey	Each	$5,009	6	$30,053
Five Year Reviews Reports	Each	$18,001	6	$108,007
Subtotal				**$138,060**
	SUPERVISION AND ADMIN @ 8%			$11,045
	CONTINGENCY @ 30%			$41,418
	SUBTOTAL (Years 5, 10, 15, 20, 25, 30)			**$190,522**
Incidental Destruction of MDEH (Years 10, 20, 30)				
Incidental Destruction of MDEH	Each	$3,003	3	$9,008
Subtotal				**$9,008**
	SUPERVISION AND ADMIN @ 8%			$721
	CONTINGENCY @ 30%			$2,702
	SUBTOTAL (Years 10, 20, 30)			**$12,431**
	TOTAL PERIODIC COSTS			**$202,953**
	PERIODIC PRESENT WORTH (2.8%)			**$128,141**

Assumptions:

These costs are for comparison purposes only and have an accuracy of +50% or -30%. Many design variables and necessary activities have not been established.

Table B-2
Fuze and Booster Quarry MRS
Alternative 2: Land Use Controls

COST ELEMENTS										
TASK	SUBTASK		PRICE TYPE	LABOR HOURS	LABOR DOLLARS	ODCs	TRAVEL	SUB-CONTRACTORS	SUBTASK TOTAL	TASK TOTAL
1		**Land Use Control Implementation Plan**	**FFP**							**$9,757.94**
	1.1	Land Use Control Implementation Plan	FFP	90.00	$9,619.94	$138.00			$9,757.94	
2		**LUC Implementation**	**FFP**							**$5,057.01**
	2.1	LUC Awareness Training		27.00	$2,800.49	$469.00			$3,269.49	
	2.2	Educational Controls-Briefing Handouts	FFP	22.00	$1,787.52				$1,787.52	
3		**Institutional Controls Maintenance**	**FFP**							**$5,798.15**
	3.1	Munitions Awareness Training		24.00	$1,475.92	$100.00	$1,219.53		$2,795.45	
	3.2	Incidental Destruction of MDEH		15.00	$1,106.12	$931.85	$802.73	$162.00	$3,002.70	
		TOTAL FIRM FIXED PRICE		**178.00**	**$16,789.99**	**$1,638.85**	**$2,022.26**	**$162.00**		**$20,613.10**

Table B-3
Fuze and Booster Quarry MRS
Alternative 2, Land Use Controls
Task Details

		Subtask 1.1			
		Land Use Control Implementation Plan		Total	
	Project Rate	**Hours/Qty**	**Dollars**	**Hours/Qty**	**Dollars**
Labor Category (Home Site)					
Corporate Quality Manager	$163.06	8.00	$1,304.48	8.00	$1,304.48
Senior Project Manager	$163.06	24.00	$3,913.44	24.00	$3,913.44
Geographic Information Systems (GIS) Specialist	$102.49	10.00	$1,024.90	10.00	$1,024.90
Junior Environmental Engineer	$77.14	32.00	$2,468.48	32.00	$2,468.48
Administrative Assistant	$56.79	16.00	$908.64	16.00	$908.64
TOTAL HOME SITE LABOR		**90.00**	**$9,619.94**	**90.00**	**$9,619.94**
TOTAL LABOR		**90.00**	**$9,619.94**	**90.00**	**$9,619.94**
OTHER DIRECT COSTS:	**Rate**	**Quantity**	**Dollars**	**Quantity**	**Dollars**
FedEx shipments (Reston to Baltimore, 20lbs)	$23.00	6.00	$138.00	6.00	$138.00
TOTAL OTHER DIRECT COSTS			**$138.00**		**$138.00**
FIRM-FIXED PRICE			**$9,757.94**		**$9,757.94**
ASSUMPTIONS:					

Based on existing interim controls currently in place for all of Camp Ravenna, the Fuze and Booster Quarry MRS LUCs will document inclusion of the MRS in the current procedures for LUC Awareness Training already implemented by Camp Ravenna. The Land Use Controls Implementation Plan for Fuze and Booster Quarry MRS will document the location of this MRS and document the inclusion of the MRS in required briefings and annual training. The Property Management Plan update to Appendix A is already funded under an existing project and is not included in this cost estimate.

Table B-4
Fuze and Booster Quarry MRS
Alternative 2, Land Use Controls
Task Details

			Subtask 2.1		Subtask 2.2			
			LUC Awareness Training		Educational Controls-Briefing Handouts		Total	
		Project Rate	**Hours/Qty**	**Dollars**	**Hours/Qty**	**Dollars**	**Hours/Qty**	**Dollars**
Labor Category (Home Site)								
Senior Project Manager		$163.06	8.00	$1,304.48	2.00	$326.12	10.00	$1,630.60
Geographic Information Systems (GIS) Specialist		$102.49	2.00	$204.98			2.00	$204.98
Junior Environmental Engineer		$77.14	16.00	$1,234.24	16.00	$1,234.24	32.00	$2,468.48
Administrative Assistant		$56.79	1.00	$56.79	4.00	$227.16	5.00	$283.95
TOTAL HOME SITE LABOR			**27.00**	**$2,800.49**	**22.00**	**$1,787.52**	**49.00**	**$4,588.01**
TOTAL LABOR			**27.00**	**$2,800.49**	**22.00**	**$1,787.52**	**49.00**	**$4,588.01**
OTHER DIRECT COSTS:	**Unit of Measure**	**Rate**	**Quantity**	**Dollars**			**Quantity**	**Dollars**
FedEx shipments (Reston to Baltimore, 20lbs)	package	$23.00	3.00	$69.00			3.00	$69.00
Printing	each	$200.00	2.00	$400.00			2.00	$400.00
TOTAL OTHER DIRECT COSTS				**$469.00**				**$469.00**
FIRM-FIXED PRICE				**$3,269.49**		**$1,787.52**		**$5,057.01**
ASSUMPTIONS:								

The original LUC Awareness Training materials will be developed as part of the Property Management Plan Appendix A which is funded under a separate project. Subtask 2.1, will include any revisions required for specific materials related to the Fuze and Booster Quarry MRS or updates to the Property Management Plan materials. Subtask 2.2, Educational Controls-Briefing Handouts will include any additional revisions required to handouts or sign-in sheets, specific to Fuze and Booster Quarry MRS.

Table B-5
Fuze and Booster Quarry MRS
Alternative 2, Land Use Controls
Task Details

	Subtask 3.1 Future LUC Awareness Training (Annual)		Subtask 3.2 Incidental Destruction of MDEH (Annual)		Total	
	Hours/Qty	**Dollars**	**Hours/Qty**	**Dollars**	**Hours/Qty**	**Dollars**
Labor Category (Field Site)						
Senior UXO Supervisor (SUXOS)			3.00	$255.57	3.00	$255.57
Senior UXO Supervisor (SUXOS) (8% Hazard)			2.00	$184.02	2.00	$184.02
UXO Safety Officer (UXOSO)			3.00	$255.57	3.00	$255.57
UXO Safety Officer (UXOSO) (8% Hazard)			2.00	$184.02	2.00	$184.02
UXO Technician II **			3.00	$131.94	3.00	$131.94
UXO Technician II (8% Hazard)			2.00	$95.00	2.00	$95.00
UXO Technician III **	16.00	$843.36			16.00	$843.36
UXO Technician III (OT)	8.00	$632.56			8.00	$632.56
TOTAL FIELD SITE LABOR	**24.00**	**$1,475.92**	**15.00**	**$1,106.12**	**39.00**	**$2,582.04**
TOTAL LABOR	**24.00**	**$1,475.92**	**15.00**	**$1,106.12**	**39.00**	**$2,582.04**
OTHER DIRECT COSTS:	**Quantity**	**Dollars**	**Quantity**	**Dollars**	**Quantity**	**Dollars**
Printing	1.00	$100.00			1.00	$100.00
TAXABLE COSTS:						
Type II Magazine Rental			0.20	$40.00	0.20	$40.00
Donor Explosives (purchased for storage)			0.20	$604.13	0.20	$604.13
Type II Magazine Delivery/Setup			0.20	$200.00	0.20	$200.00
Sandbag, 50-lb, all purpose			10.00	$28.80	10.00	$28.80
Sales Tax				$58.92		$58.92
TOTAL OTHER DIRECT COSTS		**$100.00**		**$931.85**		**$1,031.85**
TRAVEL		**$1,219.53**		**$802.73**		**$2,022.26**
SUBCONTRACTORS:						
Analytical Laboratory				$162.00		$162.00
TOTAL SUBCONTRACTORS				**$162.00**		**$162.00**
FIRM-FIXED PRICE		**$2,795.45**		**$3,002.70**		**$5,798.15**
ASSUMPTIONS:						

Subtask 3.1 covers two days of training provided by a UXO Technician for any specific briefings necessary for this MRS, travel costs for the UXO Technician to mobilize, and printing of briefing materials. The original version of the LUC Awareness Training materials will be developed as part of the Property Management Plan Appendix A which is funded under a separate project with updates created in Subtask 1 and Subtask 2. These costs are for future annual training events.

Subtask 3.2 covers the incidental offsite (off the MRS) destruction of any MPPEH confirmed to be MDEH. It is assumed one item per every 5 years will be located and transported to the Open Demolition Area #2 for destruction. Therefore, Subtask 3.2 shows the annual cost (one-fifth) of the total for MPPEH Destruction to occur once over a five year period.
Travel costs for the demolition team (SUXOS, the dual-hatted UXOSO/UXOQCS and one UXO Technician II) to mobilize/demobilize are included.
One 10-hour day, at 8% uplift, is estimated for accepting delivery of explosives and conducting MDEH demolition.

Table B-6
Fuze and Booster Quarry MRS
Alternative 4: Subsurface MPPEH Removal to 2 Feet (UU/UE)

ITEM	UNIT	UNIT COST	QUANTITY	TOTAL
CAPITAL COSTS				
Reporting/Workplans				
Remedial Action Work Plan	Lump Sum	$57,199	1	$57,199
Explosives Safety Submission	Lump Sum	$10,429	1	$10,429
Remedial Action Report	Lump Sum	$40,592	1	$40,592
Subtotal				**$108,220**
Mobilization/Demobilization				
Labor and Travel Time	Lump Sum	$13,874	1	$13,874
Airfare/Mileage and Per Diem	Lump Sum	$12,607	1	$12,607
Equipment for mobilization	Lump Sum	$6,405	1	$6,405
Subtotal				**$32,886**
MEC Subsurface Removal to 2 ft				
Surveying and Mapping	Lump Sum	$6,378	1	$6,378
Vegetation Removal	Acre	$25,112	2.5	$62,780
Digital Geophysical Mapping	Acre	$14,799	2.5	$36,998
Reaquire and Intrusive Investigation	Lump Sum	$43,490	1	$43,490
MEC and MPPEH Disposal and MC Sampling	Lump Sum	$36,507	1	$36,507
Subtotal				**$186,153**
	SUBTOTAL			**$327,258**
	SUPERVISION AND ADMIN @ 8%			$26,181
	CONTINGENCY @ 30%			$98,177
	TOTAL CAPITAL COSTS			**$451,616**
ANNUAL O&M COSTS				
	SUBTOTAL (ANNUALLY)			**$0**
	SUPERVISION AND ADMIN @ 8%			$0
	CONTINGENCY @ 30%			$0
	TOTAL ANNUAL O&M COSTS			**$0**
	TOTAL O&M COSTS (30 Years)			**$0**
	O&M PRESENT WORTH (30 Years at 2.8%)			**$0**
TOTAL ALTERNATIVE COST (Capital + O&M Present Worth)				**$451,616**

5-YEAR REVIEWS				
Site Visit and Enhanced Visual Survey	Lump Sum	$0	1	$0
Five Year Reviews Reports	Report	$0	1	$0
Total				**$0**

Table B-7
Fuze and Booster Quarry MRS
Alternative 4, Subsurface MPPEH
Removal to 2 feet (UU/UE)

COST ELEMENTS									
TASK	SUBTASK		LABOR HOURS	LABOR DOLLARS	ODCs	TRAVEL	SUB-CONTRACTORS	SUBTASK TOTAL	TASK TOTAL
1		**Work Plans**							**$108,219.98**
	1.1	Remedial Action Work Plan	524.00	57,060.96	$138.00			$57,198.96	
	1.2	Explosive Safety Submission	106.00	10,429.10				$10,429.10	
	1.3	Remedial Action Report	380.00	40,453.92	$138.00			$40,591.92	
2		**Remedial Action: DGM And Subsurface Clearance of MEC**							**$219,038.21**
	2.1	Mobilization/Demobilization	208.00	13,873.76	$6,405.00	$12,606.84		$32,885.60	
	2.2	Surveying and Mapping	30.00	2,637.54		$740.25	$3,000.00	$6,377.79	
	2.3	Vegetation Removal	258.00	48,913.32	$7,481.14	$6,385.82		$62,780.28	
	2.4	Digital Geophysical Mapping	238.00	23,063.04	$9,136.25	$4,798.57		$36,997.86	
	2.5	Reacquire and Intrusive Investigation	486.00	24,809.62	$7,495.50	$11,184.39		$43,489.51	
	2.6	MEC and MPPEH Disposal and MC Sampling	144.00	12,742.08	$18,469.00	$986.09	$4,310.00	$36,507.17	
		TOTAL FIRM FIXED PRICE	**2,374.00**	**$233,983.34**	**$49,262.89**	**$36,701.96**	**$7,310.00**		**$327,258.19**

Table B-8
Fuze and Booster Quarry MRS
Alternative 4, Subsurface MPPEH
Removal to 2 feet (UU/UE)

		Subtask 1.1		**Subtask 1.2**		**Subtask 1.3**			
		Remedial Action Work Plan		Explosive Safety Submission		Remedial Action Completion Report		**Total**	
	Project Rate	**Hours/Qty**	**Dollars**	**Hours/Qty**	**Dollars**	**Hours/Qty**	**Dollars**	**Hours/Qty**	**Dollars**
Labor Category (Home Site)									
Corporate Quality Manager	$163.06	8.00	$1,304.48	4.00	$652.24	8.00	$1,304.48	20.00	$3,261.20
Senior Project Manager	$163.06	60.00	$9,783.60	24.00	$3,913.44	48.00	$7,826.88	132.00	$21,523.92
Senior Geophysicist	$163.06	20.00	$3,261.20			20.00	$3,261.20	40.00	$6,522.40
Junior Geophysicist	$102.49	48.00	$4,919.52			48.00	$4,919.52	96.00	$9,839.04
Junior Geologist	$77.14	120.00	$9,256.80			60.00	$4,628.40	180.00	$13,885.20
Certified Industrial Hygienist (CIH)	$163.06	8.00	$1,304.48					8.00	$1,304.48
Geographic Information Systems (GIS) Specialist	$102.49	24.00	$2,459.76	10.00	$1,024.90	24.00	$2,459.76	58.00	$5,944.42
Senior Risk Assessor	$163.06	24.00	$3,913.44					24.00	$3,913.44
Senior Environmental Engineer	$163.06	60.00	$9,783.60			40.00	$6,522.40	100.00	$16,306.00
Junior Environmental Engineer	$77.14	120.00	$9,256.80	48.00	$3,702.72	100.00	$7,714.00	268.00	$20,673.52
Administrative Assistant	$56.79	32.00	$1,817.28	20.00	$1,135.80	32.00	$1,817.28	84.00	$4,770.36
TOTAL HOME SITE LABOR		**524.00**	**$57,060.96**	**106.00**	**$10,429.10**	**380.00**	**$40,453.92**	**1,010.00**	**$107,943.98**
TOTAL LABOR		**524.00**	**$57,060.96**	**106.00**	**$10,429.10**	**380.00**	**$40,453.92**	**1,010.00**	**$107,943.98**
OTHER DIRECT COSTS:	**Rate**	**Quantity**	**Dollars**	**Quantity**	**Dollars**	**Quantity**	**Dollars**	**Quantity**	**Dollars**
FedEx shipments (Reston to Baltimore, 20lbs)	$23.00	6.00	$138.00			6.00	$138.00	12.00	$276.00
TOTAL OTHER DIRECT COSTS			**$138.00**				**$138.00**		**$276.00**
FIRM-FIXED PRICE			**$57,198.96**		**$10,429.10**		**$40,591.92**		**$108,219.98**

Table B-9
Fuze and Booster Quarry MRS
Alternative 4, Subsurface MPPEH
Removal to 2 feet (UU/UE)

			Subtask 2.1		**Subtask 2.2**		**Subtask 2.3**		**Subtask 2.4**	
			Mobilization/Demobilization		Surveying and Mapping		Vegetation Removal		Digital Geophysical Mapping	
		Project Rate	**Hours/Qty**	**Dollars**	**Hours/Qty**	**Dollars**	**Hours/Qty**	**Dollars**	**Hours/Qty**	**Dollars**
Labor Category (Home Site)										
Senior Project Manager		$163.06	16.00	$2,608.96			4.00		4.00	$652.24
Senior Geophysicist		$163.06							30.00	$4,891.80
Junior Geophysicist		$102.49	16.00	$1,639.84					50.00	$5,124.50
Senior Chemist		$163.06								
Junior Chemist		$77.14								
Junior Geologist		$77.14	16.00	$1,234.24						
Administrative Assistant		$56.79					4.00	$227.16	4.00	$227.16
TOTAL HOME SITE LABOR			**48.00**	**$5,483.04**			**8.00**	**$227.16**	**88.00**	**$10,895.70**
Senior UXO Supervisor (SUXOS)		$85.19	16.00	$1,363.04	6.00	$511.14	8.00	$681.52	8.00	$681.52
Senior UXO Supervisor (SUXOS) (OT)		$127.79					2.00	$255.58	2.00	$255.58
Senior UXO Supervisor (SUXOS) (4% Hazard)		$88.60			24.00	$2,126.40	32.00	$2,835.20	32.00	$2,835.20
Senior UXO Supervisor (SUXOS) (4% Hazard) (OT)		$132.90					8.00	$1,063.20	8.00	$1,063.20
Senior UXO Supervisor (SUXOS) (8% Hazard)		$92.01								
Senior UXO Supervisor (SUXOS) (8% Hazard) (OT)		$138.02								
UXO Safety Officer (UXOSO)		$85.19	16.00	$1,363.04				$12,778.50	8.00	$681.52
UXO Safety Officer (UXOSO) (OT)		$127.79							2.00	$255.58
UXO Safety Officer (UXOSO) (4% Hazard)		$88.60						$21,086.80	32.00	$2,835.20
UXO Safety Officer (UXOSO) (4% Hazard) (OT)		$132.90							8.00	$1,063.20
UXO Safety Officer (UXOSO) (8% Hazard)		$92.01								
UXO Safety Officer (UXOSO) (8% Hazard) (OT)		$138.02								
UXO Technician I **		$36.35	32.00	$1,163.20						
UXO Technician II **		$43.98	64.00	$2,814.72			32.00	$1,407.36	8.00	$351.84
UXO Technician II (OT)		$65.97					8.00	$527.76	2.00	$131.94
UXO Technician II (4% Hazard)		$45.74					128.00	$5,854.72	32.00	$1,463.68
UXO Technician II (4% Hazard) (OT)		$68.61					32.00	$2,195.52	8.00	$548.88
UXO Technician II (8% Hazard)		$47.50								
UXO Technician II (8% Hazard) (OT)		$71.25								
UXO Technician III **		$52.71	32.00	$1,686.72						
UXO Technician III (OT)		$79.07								
UXO Technician III (8% Hazard)		$56.93								
UXO Technician III (8% Hazard) (OT)		$85.40								
** SCA WD (Site Specific) Utilized										
TOTAL FIELD SITE LABOR			**160.00**	**$8,390.72**	**30.00**	**$2,637.54**	**250.00**	**$48,686.16**	**150.00**	**$12,167.34**
TOTAL LABOR			**208.00**	**$13,873.76**	**30.00**	**$2,637.54**	**258.00**	**$48,913.32**	**238.00**	**$23,063.04**

Table B-9
Fuze and Booster Quarry MRS
Alternative 4, Subsurface MPPEH
Removal to 2 feet (UU/UE)

			Subtask 2.1		**Subtask 2.2**		**Subtask 2.3**		**Subtask 2.4**	
			Mobilization/Demobilization		Surveying and Mapping		Vegetation Removal		Digital Geophysical Mapping	
		Project Rate	**Hours/Qty**	**Dollars**	**Hours/Qty**	**Dollars**	**Hours/Qty**	**Dollars**	**Hours/Qty**	**Dollars**
OTHER DIRECT COSTS:	**Unit of Measure**	**Rate**	**Quantity**	**Dollars**	**Quantity**	**Dollars**	**Quantity**	**Dollars**	**Quantity**	**Dollars**
FedEx shipments (Reston to Baltimore, 20lbs)	package	$23.00							12.00	$276.00
Printing	each	$200.00								
TAXABLE COSTS:										
Signs (080 aluminum cut or printed vinyl applied 1 sided, non-reflective)	each	$122.00					9.00	$1,098.00		
T-post (7 ft)	each	$5.29					134.00	$708.86		
T-post driver	each	$29.99					2.00	$59.98		
Seibert Stake	each	$21.13					125.00	$2,641.25		
Bobcat with Cutter rental	week	$1,500.00					1.00	$1,500.00		
trailer rental	week	$500.00					1.00	$500.00	1.00	$500.00
heavy equipment delivery	each	$500.00					1.00	$500.00		
explosives	shot	$3,000.00								
EM61 rental	week	$1,500.00							1.00	$1,500.00
GPS Rover	week	$900.00							2.00	$1,800.00
UTV rental	week	$1,500.00							1.00	$1,500.00
equipment	month	$3,000.00							1.00	$3,000.00
office trailer rental	month	$200.00	2.00	$6,000.00						
Sales Tax	6.75%			$405.00				$473.05		$560.25
TOTAL OTHER DIRECT COSTS				**$6,405.00**				**$7,481.14**		**$9,136.25**
TRAVEL				**$12,606.84**		**$740.25**		**$6,385.82**		**$4,798.57**
SUBCONTRACTORS:										
Surveyor						$3,000.00				
MDAS Disposal										
Analytical Laboratory										
TOTAL SUBCONTRACTORS						**$3,000.00**				
FIRM-FIXED PRICE				**$32,885.60**		**$6,377.79**		**$62,780.28**		**$36,997.86**

Table B-9
Fuze and Booster Quarry MRS
Alternative 4, Subsurface MPPEH
Removal to 2 feet (UU/UE)

			Subtask 2.5		Subtask 2.6			
			Reacquire and Intrusive Investigation		MEC and MPPEH Disposal and MC Sampling		Total	
		Project Rate	**Hours/Qty**	**Dollars**	**Hours/Qty**	**Dollars**	**Hours/Qty**	**Dollars**
Labor Category (Home Site)								
Senior Project Manager		$163.06	8.00	$1,304.48	10.00	$1,630.60	42.00	$6,196.28
Senior Geophysicist		$163.06	24.00	$3,913.44			54.00	$8,805.24
Junior Geophysicist		$102.49	50.00	$5,124.50			116.00	$11,888.84
Senior Chemist		$163.06			16.00	$2,608.96	16.00	$2,608.96
Junior Chemist		$77.14			$10.00	$771.40	10.00	$771.40
Junior Geologist		$77.14			14.00	$1,079.96	30.00	$2,314.20
Administrative Assistant		$56.79	4.00		8.00	$454.32	20.00	$908.64
TOTAL HOME SITE LABOR			**86.00**	**$10,342.42**	**58.00**	**$6,545.24**	**288.00**	**$33,493.56**
Senior UXO Supervisor (SUXOS)		$85.19	8.00	$681.52			46.00	$3,918.74
Senior UXO Supervisor (SUXOS) (OT)		$127.79	2.00	$255.58			6.00	$766.74
Senior UXO Supervisor (SUXOS) (4% Hazard)		$88.60					88.00	$7,796.80
Senior UXO Supervisor (SUXOS) (4% Hazard) (OT)		$132.90					16.00	$2,126.40
Senior UXO Supervisor (SUXOS) (8% Hazard)		$92.01	32.00		24.00	$2,208.24	56.00	$2,208.24
Senior UXO Supervisor (SUXOS) (8% Hazard) (OT)		$138.02	8.00	$1,104.16			8.00	$1,104.16
UXO Safety Officer (UXOSO)		$85.19	8.00	$681.52			32.00	$15,504.58
UXO Safety Officer (UXOSO) (OT)		$127.79	2.00	$255.58			4.00	$511.16
UXO Safety Officer (UXOSO) (4% Hazard)		$88.60					32.00	$23,922.00
UXO Safety Officer (UXOSO) (4% Hazard) (OT)		$132.90					8.00	$1,063.20
UXO Safety Officer (UXOSO) (8% Hazard)		$92.01	32.00		24.00	$2,208.24	56.00	$2,208.24
UXO Safety Officer (UXOSO) (8% Hazard) (OT)		$138.02	8.00	$1,104.16			8.00	$1,104.16
UXO Technician I **		$36.35					32.00	$1,163.20
UXO Technician II **		$43.98	32.00	$1,407.36			136.00	$5,981.28
UXO Technician II (OT)		$65.97	8.00	$527.76			18.00	$1,187.46
UXO Technician II (4% Hazard)		$45.74			14.00	$640.36	174.00	$7,958.76
UXO Technician II (4% Hazard) (OT)		$68.61					40.00	$2,744.40
UXO Technician II (8% Hazard)		$47.50	128.00		24.00	$1,140.00	152.00	$1,140.00
UXO Technician II (8% Hazard) (OT)		$71.25	32.00	$2,280.00			32.00	$2,280.00
UXO Technician III **		$52.71	16.00	$843.36			48.00	$2,530.08
UXO Technician III (OT)		$79.07	4.00	$316.28			4.00	$316.28
UXO Technician III (8% Hazard)		$56.93	64.00	$3,643.52			64.00	$3,643.52
UXO Technician III (8% Hazard) (OT)		$85.40	16.00	$1,366.40			16.00	$1,366.40
** SCA WD (Site Specific) Utilized								
TOTAL FIELD SITE LABOR			**400.00**	**$14,467.20**	**86.00**	**$6,196.84**	**1,076.00**	**$92,545.80**
TOTAL LABOR			**486.00**	**$24,809.62**	**144.00**	**$12,742.08**	**1,364.00**	**$126,039.36**

Table B-9
Fuze and Booster Quarry MRS
Alternative 4, Subsurface MPPEH
Removal to 2 feet (UU/UE)

			Subtask 2.5		Subtask 2.6			
			Reacquire and Intrusive Investigation		MEC and MPPEH Disposal and MC Sampling		Total	
		Project Rate	Hours/Qty	Dollars	Hours/Qty	Dollars	Hours/Qty	Dollars
OTHER DIRECT COSTS:	**Unit of Measure**	**Rate**	**Quantity**	**Dollars**	**Quantity**	**Dollars**	**Quantity**	**Dollars**
FedEx shipments (Reston to Baltimore, 20lbs)	package	$23.00	1.00	$23.00	3.00	$69.00	16.00	$368.00
Printing	each	$200.00			2.00	$400.00	2.00	$400.00
TAXABLE COSTS:								
Signs (080 aluminum cut or printed vinyl applied 1 sided, non-reflective)	each	$122.00					9.00	$1,098.00
T-post (7 ft)	each	$5.29					134.00	$708.86
T-post driver	each	$29.99					2.00	$59.98
Seibert Stake	each	$21.13					125.00	$2,641.25
Bobcat with Cutter rental	week	$1,500.00					1.00	$1,500.00
trailer rental	week	$500.00	1.00	$500.00			3.00	$1,500.00
heavy equipment delivery	each	$500.00	1.00	$500.00			2.00	$1,000.00
explosives	shot	$3,000.00			6.00	$18,000.00	6.00	$18,000.00
EM61 rental	week	$1,500.00					1.00	$1,500.00
GPS Rover	week	$900.00					2.00	$1,800.00
UTV rental	week	$1,500.00					1.00	$1,500.00
equipment	month	$3,000.00	2.00	$6,000.00			3.00	$9,000.00
office trailer rental	month	$200.00					2.00	$6,000.00
Sales Tax	6.75%			$472.50				$1,910.80
TOTAL OTHER DIRECT COSTS				**$7,495.50**		**$18,469.00**		**$48,986.89**
TRAVEL				**$11,184.39**		**$986.09**		**$36,701.96**
SUBCONTRACTORS:								
Surveyor								$3,000.00
MDAS Disposal						$3,500.00		$3,500.00
Analytical Laboratory						$810.00		$810.00
TOTAL SUBCONTRACTORS						**$4,310.00**		**$7,310.00**
FIRM-FIXED PRICE				**$43,489.51**		**$36,507.17**		**$219,038.21**

Table B-10
Fuze and Booster Quarry MRS
Alternative 4, Subsurface MPPEH
Removal to 2 feet (UU/UE)

Basis of Estimate, Assumptions by Task

2.1 Mobilization/Demobilization

Mobilization includes 2 8-hour days for travel to the site. One Project Manager site visit is included during the duration of the field work event. Staff mobilizations required include: SUXOS, UXOSO/UXOQCS (dual-hatted), 2 UXO Technicians Is, 4 UXO Technician IIs, 2 UXO Technician IIIs, 1 Junior Geologist, 1 Junior Geophysicist. Twelve field personnel plus the Project Manager = 13 mobilizations.

2.2 Surveying and Mapping

Surveying includes 3 10-hour work days for the SUXOS and the subcontracted surveyor.

2.3 Vegetation Removal

Vegetation removal / brush clearance includes Project Manager hours for supervision, Administrative staff support for procurement tasks. For field tasks vegetation removal includes 5 ten hour work days.
Setup and safety briefings for the subcontractor is estimated for 0.5-day. Clearance of 2.6 acres at a production rate of 0.50 acres per day is estimated to complete clearance in approximately 3.5 days. One additional day is estimated for site restoration and equipment maintenance.
Labor hours for this task include the SUXOS and 4 UXO Technician IIs. No UXOQCS is required for brush clearance tasks only.

2.4 Digitial Geophysical Mapping

Digital Geophysical Mapping (DGM) includes Project Manager hours for supervision and Administrative staff support for procurement tasks. For field tasks DGM surveying includes 5 ten hour work days.
Geophysical equipment setup, personnel safety briefings, and instrument verification strip equipment checks are estimated for 2-days. Surveying of 2.6 acres is estimated for 3-days at a production rate of 0.5 acres per day.
Labor hours for this task include the SUXOS, the UXOSO/UXOQCS (dual-hatted), the Senior Geophysicist (includes his data processing hours occuring in the office), the Junior Geophysicist and the UXO Technician escort.

Table B-10
Fuze and Booster Quarry MRS
Alternative 4, Subsurface MPPEH
Removal to 2 feet (UU/UE)

2.5 Reaquire and Intrusive

Reacquisition of anomalies and intrusive investigation includes Project Manager hours for supervision and Administrative staff support for procurement tasks.
For field tasks the intrusive investigation includes 5 ten hour work days.
The Senior Geophysicist hours include target selections and presentation of data to Government geophysicists, responding to comments, and finalization of the target list. The Junior Geophysicist hours include onsite Quality Control data collection on intrusive investigations. The intrusive investigation team includes the SUXOS, the UXOSO/UXOQCS (dual-hatted) and one dig team consisting of 4 UXO Technician IIs and 2 UXO Technician IIIs.
Labor hours for this task include the SUXOS, the UXOSO/UXOQCS (dual-hatted), the Senior Geophysicist (includes his data processing hours occuring in the office), the Junior Geophysicist and the UXO Technician escort.

2.6 MEC and MPPEH Disposal and Sampling

MPPEH inspection and disposal of confirmed MEC, along with post blow-in-place sampling includes Project Manager hours for supervision and Administrative staff support for procurement tasks. Chemist hours for data validation of samples collected and coordination with analytical laboratory are also included. A Junior Geologist will conduct environmental sampling, with one UXO Technician II escort at 4% uplift.
For field tasks: six MPPEH items are assumed to require disposal inside the MRS, without relocation. Each demolition event is estimated to take 4-hours. The demolition team includes the SUXOS, the UXOSO/UXOQCS (dual-hatted) and one UXO Technician II, all at 8% uplift.
Environmental sampling assumes 3 pre-detonation incremental sampling (IS) method samples and 3 post-detonation IS method samples.

Table B-11
Fuze and Booster Quarry MRS
5-Year Reviews

COST ELEMENTS						
	LABOR HOURS	LABOR DOLLARS	ODCs	TRAVEL	SUBTASK TOTAL	TASK TOTAL
Visual Survey and 5-Year Review						**$23,009.93**
Site Visit and Enhanced Visual Survey	52.00	2,791.22		$2,217.57	$5,008.79	
5-Year Review Report	180.00	17863.14	138		$18,001.14	
TOTAL FIRM FIXED PRICE	**247.00**	**$21,760.48**	**$1,069.85**	**$3,020.30**		**$23,009.93**

Table B-12
Fuze and Booster Quarry MRS
5-Year Reviews
Task Details

		Site Visit and Enhanced Visual Survey		5-Year Review Report	
	Project Rate	**Hours/Qty**	**Dollars**	**Hours/Qty**	**Dollars**
Labor Category (Home Site)					
Senior Project Manager	$163.06	2.00	$326.12	32.00	$5,217.92
Geographic Information Systems (GIS) Specialist	$102.49			16.00	$1,639.84
Senior Environmental Engineer	$163.06			20.00	$3,261.20
Junior Environmental Engineer	$77.14			70.00	$5,399.80
Administrative Assistant	$56.79	2.00	$113.58	32.00	$1,817.28
TOTAL HOME SITE LABOR		**4.00**	**$439.70**	**170.00**	**$17,336.04**
UXO Technician II **	$43.98	16.00	$703.68		
UXO Technician II (4% Hazard)	$45.74	8.00	$365.92		
UXO Technician III **	$52.71	16.00	$843.36	10.00	$527.10
UXO Technician III (4% Hazard)	$54.82	8.00	$438.56		
TOTAL FIELD SITE LABOR		**48.00**	**$2,351.52**	**10.00**	**$527.10**
TOTAL LABOR		**52.00**	**$2,791.22**	**180.00**	**$17,863.14**
OTHER DIRECT COSTS:	**Rate**	**Quantity**	**Dollars**	**Quantity**	**Dollars**
FedEx shipments (Reston to Baltimore, 20lbs)	$23.00			6.00	$138.00
TOTAL OTHER DIRECT COSTS					**$138.00**
TRAVEL			**$2,217.57**		
FIRM-FIXED PRICE			**$5,008.79**		**$18,001.14**
ASSUMPTIONS:					
This Task is used to calculate the 5-year Review reporting and visual survey costs required.					