ARCADIS
Infrastructure, environment, facilities

Imagine the result

Final Focused Feasibility Study

Former Mortar Range Munitions Response Area

Fort George G. Meade, Maryland

June 2012

Shelly K. Morris
Phase Manager

Tim Llewellyn
Project Manager

Final Focused Feasibility Study
Former Mortar Range
Munitions Response Area

Fort George G. Meade, Maryland

Prepared for:
U.S. Army

Prepared by:
ARCADIS U.S., Inc.
300 E. Lombard St.
Suite 1510
Baltimore, Maryland 21202
Tel: 410-230-0680
Fax: 410-230-0491

Date:
June 2012

Table of Contents

Executive Summary **1**

1. Introduction **1-1**

1.1 Purpose of Report 1-1

1.2 Report Organization 1-2

2. Background Information **2-1**

2.1 Installation Overview 2-1

2.2 Site Description 2-1

2.3 Topography 2-2

2.4 Surface Water Hydrology 2-3

2.5 Geology 2-3

2.6 Soils 2-4

2.7 Hydrogeology 2-4

3. Site Summary **3-1**

3.1 Summary of Previous Investigations 3-1

3.1.1 Closed, Transferring, and Transferred Range and Site Inventory 3-1

3.1.2 Environmental Baseline Survey 3-1

3.1.3 Historical Records Review 3-2

3.1.4 Site Inspection 3-3

3.1.5 Remedial Investigation 3-3

3.1.6 Preliminary Assessment / Site Inspection, Golf Course Area of Interest 3-6

3.1.7 Munitions-Related Findings 3-6

3.2 Nature and Extent of MEC/ MPPEH 3-7

3.3 Summary of the Risk Assessments 3-8

4. Remedial Action Objectives **4-1**

4.1 Identification of Hazards 4-1

4.2 Scope of the Remedial Action 4-1

4.3 Identification of Applicable or Relevant and Appropriate Requirements 4-1

4.3.1 Definition of Applicable or Relevant and Appropriate Requirements 4-1

4.3.2 Development of ARARs and TBCs 4-2

4.3.3 Identification of ARARs and TBCs 4-3

4.3.3.1 Chemical-Specific ARARs and TBCs 4-3

4.3.3.2 Location-Specific ARARs and TBCs 4-3

4.3.3.3 Action-Specific ARARs and TBCs 4-3

4.4 Remedial Action Objectives 4-3

4.5 Identification of Remediation Goals 4-3

5. Development of Remedial Action Alternatives 5-1

5.1 Alternative 1 – No Action 5-1

5.2 Alternative 2 – Land Use Controls with Long Term Management 5-1

5.3 Alternative 3 –Surface and Subsurface Removal with LUCs with LTM 5-4

6. Detailed Evaluation of Remedial Alternatives 6-1

6.1 Evaluation Criteria 6-1

6.1.1 Overall Protection of Human Health and the Environment 6-2

6.1.2 Compliance with ARARs 6-2

6.1.3 Long-Term Effectiveness and Permanence 6-2

6.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment 6-2

6.1.5 Short-Term Effectiveness 6-2

6.1.6 Implementability 6-2

6.1.7 Cost 6-2

6.1.7.1 Direct Capital Cost 6-3

6.1.7.2 Indirect Capital Cost 6-3

6.1.7.3 Operation and Maintenance Cost 6-3

6.2 Analysis of Alternatives 6-4

6.2.1 Individual Analysis of Alternatives 6-4

6.2.1.1 Alternative 1 - No Action 6-4

6.2.1.2 Alternative 2 – LUCs and LTM 6-5

6.2.1.3 Alternative 3 –Surface and Subsurface Removal, with LUCs, and LTM. 6-6

6.2.2 Comparative Analysis of Alternatives 6-8

7. References 7-1

Tables

Table 4-1: Action-Specific Applicable or Relevant and Appropriate Requirement

Table 6-1: Remedial Alternatives Compared to Criteria

Table 6-2: Remedial Alternatives Cost Summary

Figures

Figure 2-1: Fort George G. Meade Site Location Map

Figure 2-2: 1923 Special Military Map with Former Mortar Range

Figure 2-3: Hydrology

Figure 3-1: Results from the RI Report

Figure 3-2: PA/SI Site Boundaries and Munitions-Related Findings

Appendices

A Detailed Remedial Cost Analyses

B Response to Comments

Acronyms and Abbreviations

%	percent
µg/kg	Micrograms per kilogram
AEDBR	Army Environmental Database Restoration
amsl	above mean sea level
AOI	Area of Interest
AR	Army Regulation
ARAR	Applicable or Relevant and Appropriate Requirement
bgs	below ground surface
BRAC	Base Realignment and Closure
cal	caliber
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act (1980)
CFR	Code of Federal Regulations
CTT	Closed, Transferring and Transferred
DDESB	Department of Defense Explosives Safety Board
DGM	Digital Geophysical Mapping
DMM	Discarded Military Munitions
DoD	U.S. Department of Defense
EBS	Environmental Baseline Survey
EC	Engineering Control
EOD	Explosives Ordnance Disposal
EP	Engineer Pamphlet
FFS	Focused Feasibility Study
FGGM	Fort George G. Meade
ft	feet
GIS	Geographical Information System
HA	Hazard Assessment
HHRA	Human Health Risk Assessment
HRR	Historical Records Review
IC	Institutional Control

Acronyms and Abbreviations

ID	Identification
in/hr	inches per hour
IRP	Installation Restoration Program
LTM	Long-Term Management
LUC	Land Use Control
MC	Munitions Constituents
MCOC	Munitions Constituents of Concern
MCL	Maximum Contaminant Level
MD	Maryland
MDE	Maryland Department of the Environment
MEC	Munitions and Explosives of Concern
MGS	Maryland Geological Survey
mm	millimeter
MMRP	Military Munitions Response Program
MPPEH	Material Potentially Presenting an Explosive Hazard
MRA	Munitions Response Area
MRS	Munitions Response Site
MRSPP	Munitions Response Site Prioritization Protocol
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NFA	No Further Action
OESS	Ordnance and Explosives Safety Specialist
O&M	Operation and Maintenance
PA	Preliminary Assessment
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RDX	Cyclotrimethylene trinitramine
RG	Remediation Goal
RI	Remedial Investigation
RSL	Regional Screening Level

Acronyms and Abbreviations

SARA	Superfund Amendments and Reauthorization Act (1986)
SI	Site Inspection
SLERA	Screening Level Ecological Risk Assessment
TBC	to-be-considered
TNT	trinitrotoluene
U. S.	United States
USACE	U.S. Army Corps of Engineers
USAEC	U.S. Army Environmental Command
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
UXO	Unexploded Ordnance

Executive Summary

This Focused Feasibility Study (FFS) was prepared for the former Mortar Range Munitions Response Area (MRA) (FGGM-003-R) at Fort George G. Meade (FGGM), Maryland (MD). This FFS presents an evaluation of possible munitions response actions at the two Munitions Response Sites (MRS) within the MRA. These two MRSs are the 62-acre Mortar Area MRS [Army Environmental Database Restoration (AEDB-R) Identification (ID): FGGM-003-R-01] and the 260-acre Training Area MRS (AEDB-R ID: FGGM-003-R-02). This document is in accordance with the requirements of the Military Munitions Response Program (MMRP) and Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

A Remedial Investigation (RI) was conducted between 2007 and 2011 (ARCADIS/Malcolm Pirnie, 2011), to develop sufficient information on potential Munitions and Explosives of Concern (MEC), Material Potentially Presenting an Explosive Hazard (MPPEH), and Munitions Constituents (MC). Data generated were used to assess the potential safety hazards and/or risks to enable selection of a cost effective and efficient response action. A qualitative analysis of explosive risk was conducted to assess potential risks associated with MEC and MPPEH, and human health and ecological risk assessments were conducted to assess potential risks associated with MC.

- The qualitative explosive risk assessment concluded that, since only small arms ammunition (not presenting a unique explosive hazard), munitions debris and evidence of only training items with no explosive configuration were identified during the 2011 RI, there is a low probability for human receptors to encounter MEC on the MRSs.
- The Human Health Risk Assessment (HHRA) concluded that, based on comparison of the maximum detected munitions constituents of concern (MCOC)[1] concentrations to chemical-specific Regional Screening Levels (RSL), no Contaminants of Potential Concern were identified for either of the MRSs. Therefore, there are no unacceptable human health risks associated with the MC.
- The Screening Level Ecological Risk Assessment (SLERA) concluded that adverse health effects in ecological receptors from exposure to MC in surface soil are not likely at either of the MRSs, and no Contaminants of Potential Ecological Concern associated with MC metals were identified.

---

[1] Based on the munitions debris encountered during the RI MEC field effort, the MCOC identified for the MRA included a select set of metals (i.e., antimony, copper, lead, magnesium, mercury, and zinc), explosives (including nitroglycerin), and nitrocellulose (collected at the Mortar Area MRS only).

Based on the results of the RI, safety hazards associated with MEC and MPPEH may exist at both the Mortar Area MRS and the Training Area MRS on the former Mortar Range MRA. Although the probability of MEC or MPPEH being encountered is low, the acute nature of the hazard warrants consideration of a munitions response action. Based on the result of HHRA and SLERA, no further investigation or munitions response actions related to MC are warranted as there are no unacceptable risks. Therefore, the MEC / MPPEH safety hazard is the sole focus of this FFS.

The proposed Remedial Action Objective (RAO) for both of the MRSs included in this FFS is:

- Control and minimize the potential for contact of receptors with possible MEC at the surface and within the subsurface.

It is important to note that once a MEC area is identified, there will always be a residual risk of exposure regardless of the remedial action chosen. The limit of technology for the detection and removal of MEC, combined with the nature of the hazard (explosive), results in a residual risk that was considered when evaluating remedial alternatives. These considerations included the fact that institutional controls would be required at this site even after an exhaustive removal action for 100 percent removal of MEC / MPPEH safety hazards due to the limitations on available detection and removal technologies.

Remedial alternatives were developed to meet the RAO and to thereby address the hazards posed by the MEC / MPPEH. The remedial alternatives developed and evaluated are listed below.

- Alternative 1 – No Action;
- Alternative 2 –Land Use Controls (LUCs) with Long Term Management (LTM); and
- Alternative 3 – Surface and Subsurface Removal, LUCs, and LTM.

In order to compare the alternatives, each was evaluated on an individual basis against the nine criteria identified in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). The nine criteria include the two threshold criteria of overall protection of human health and the environment and compliance with Applicable or Relevant and Appropriate Requirements (ARARs); the five balancing criteria of long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; implementability; and cost; and the two modifying criteria of state acceptance and community acceptance which are evaluated during the Proposed Plan.

The comparative analysis evaluated the anticipated performance of each alternative against each other. This analysis is designed to expose the strengths and weaknesses of each alternative and provide a considered basis for identification of the recommended alternatives.

During the FFS process, it was determined that both MRSs share the same explosive risks, and, therefore, the same remedial alternative. Therefore, the two MRSs have been evaluated as one MRA in this document. However, MRS-specific differences in remedies and site controls will be addressed as part of Proposed Plan.

Based on the analysis, Alternative 2 provides benefits over Alternative 3 at both MRSs, as Alternative 2 is equally protective, scores higher in terms of short term effectiveness, can be implemented relatively quickly, and is less costly than Alternative 3. This alternative would meet the RAO and Remedial Goals while providing the optimum balance with respect to the evaluation criteria. This alternative is protective of human health and the environment, complies with ARARs, is implementable; limits short term safety hazard to the community and site workers, and is less costly. LUCs with LTM, to include the requirement of changes to dig permits for Unexploded Ordnance construction support during any intrusive activities, will allow for site redevelopment for military/industrial use which is the planned future use for the MRA.

1. Introduction

ARCADIS U.S., Inc. has been retained by the United States (U.S.) Army Environmental Command (USAEC) to support the Installation Restoration Program (IRP) and Military Munitions Response Program (MMRP) activities at Fort George G. Meade (FGGM), located in Anne Arundel County, Maryland (MD). This work is being conducted under a Performance Based Contract associated with the environmental restoration program at FGGM. The full scope of services for this contract is defined in Contract W91ZLK-05-D-0015: Task 0005.

The IRP and MMRP activities at FGGM operate principally under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986 and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) [40 Code of Federal Regulations (CFR) 300]. Coordination and input are provided by the U.S. Environmental Protection Agency (USEPA) Region III. The Maryland Department of the Environment (MDE) is also a stakeholder in the environmental restoration program at FGGM.

1.1 Purpose of Report

This report presents the methodology and results of a Focused Feasibility Study (FFS) conducted under the MMRP to address munitions and explosives of concern (MEC) at the former Mortar Range Munitions Response Area (MRA). The purpose of the FFS is to develop and evaluate remedial alternatives to assist in the selection of an appropriate munitions response action for the former Mortar Range MRA. This FFS addresses mitigation of MEC hazards through the completion of the following tasks:

- Develop Remedial Action Objectives (RAOs) for specific constituents, affected media, and exposure pathways;
- Identify remedial technologies that, alone or in combination, can treat, contain, or remove and dispose of contaminated media;
- Conduct a detailed analysis of the remedial alternatives using the nine evaluation criteria listed in the NCP;
- Screen the remedial technologies to eliminate those that are not implementable, not effective, or too costly;
- Assemble the remedial technologies into remedial alternatives, which, to the maximum extent practicable, utilize permanent solutions and alternative technologies; to remediate principal threat wastes; and
- Select a remedial alternative that is the best balance of the nine evaluation criteria.

Based on the results of the Human Health Risk Assessment (HHRA) and Screening Level Ecological Risk Assessment (SLERA), there are no unacceptable human health

risks or adverse health effects to ecological receptors from munitions constituents (MC) at this MRA. Therefore, the focus of this report is solely the explosive risks due to MEC / Material Potentially Presenting an Explosive Hazard (MPPEH).

As part of the 2011 Remedial Investigation (RI), the former Mortar Range MRA was split into the Mortar Area Munitions Response Site (MRS) and the Training Area MRS. This was based on past use of the site, as a mortar range and a training area, respectively. During the FFS process, it was determined that both MRSs share the same explosive risks, and, therefore, the same remedial alternative. Therefore, the two MRSs will be evaluated as one MRA in this document.

1.2 Report Organization

In addition to this introduction, the FFS is divided into seven sections as follows:

- Section 2 – Background Information: This section presents information regarding FGGM and the former Mortar Range MRA. The installation history, geology, topography, hydrogeology, and surface water are discussed.

- Section 3 – Site Summary: This section provides information regarding the site characteristics, site description, and site history. The scope and results of previous environmental investigations are summarized, as are the evaluations of human health risk resulting from exposure to contaminants present at the site.

- Section 4 – Remedial Action Objectives: RAOs are identified for the site and Applicable or Relevant and Appropriate Requirement (ARARs) are identified where applicable.

- Section 5 – Development of Response Action Alternatives: Remedial alternatives are developed by combining the remedial technologies which successfully passed an initial screening process.

- Section 6 – Detailed Evaluation of Remedial Alternatives: A detailed evaluation of the alternatives retained from the initial screening process is presented using the nine NCP evaluation criteria [40 CFR 300.430(e)].

- Section 7 – References: The references used to develop this FFS are presented.

2. Background Information

This section provides a summary of the history and environmental setting of FGGM and specifically the former Mortar Range MRA, which is the focus of this FFS.

2.1 Installation Overview

FGGM is located in Anne Arundel County, MD, almost midway between the cities of Baltimore, MD, and Washington, District of Columbia. FGGM lies approximately four miles east of Interstate 95 and immediately east of the Baltimore-Washington Parkway (MD Route 295), between MD Routes 175 and 32 (**Figure 2-1**). FGGM is located near the communities of Odenton, Laurel, Columbia, and Jessup. Following the 1988 Base Realignment and Closure (BRAC), the installation covers 5,415 acres. The current installation boundaries encompass the area previously referred to as the cantonment area, which is used for administrative, recreational, and housing facilities. FGGM currently contains approximately 65.5 miles of paved roads, 3.3 miles of secondary roads, and about 1,300 buildings.

2.2 Site Description

The former Mortar Range MRA is a former range and training area located in the west-central portion of FGGM (**Figure 2-1**). The former Mortar Range MRA was first identified on a 1923 Special Military Map for Camp Meade as a 59-acre range (**Figure 2-2**). The former Mortar Range is also shown on a 1924 War Game Map for Camp Meade but does not appear on any maps after 1924, and no reference is made to it in historical documents. As presented in the Site Inspection (SI) and based on historical maps and evidence collected during the RI, the site was used as a mortar range beginning in the early 1920s (Malcolm Pirnie, 2006). Training was assumed to have ended in the 1940s based on munitions debris found during the RI.

The majority of the former Mortar Range MRA has been used as a golf course since 1956. A jogging trail is present along the western edge of the golf course. The northwestern portion of the site is Department of Defense (DoD) property and is developed with buildings and associated paved surfaces (i.e., roadways, parking lots, and walkways). As of early 2012, construction of additional DoD buildings began on the area that had been the golf course and jogging trail. As a result of this construction, the golf course and jogging trail have been permanently closed.

During the RI, no MEC (except small arms ammunition not presenting a unique explosive hazard) were found on the MRA; however, munitions debris from 60 and 81 millimeter (mm) training mortar rounds, 3-inch Stokes training mortar rounds, a training landmine, flares, practice grenades, a dummy grenade, discarded small arms ammunition, and casings from expended small arms ammunition were found during the RI MEC field activities. The training mortar rounds, identified during the RI MEC field activities, were concentrated in an area corresponding to the original location of the former Mortar Range shown on maps from the 1920s. An analysis of historical aerial

photographs, performed during the RI, confirmed the Mortar Area MRS boundary. Additionally, a number of training areas within the former Mortar Range MRA were observed and the former Mortar Range MRA boundary was found to extend east to Taylor Avenue beyond the boundary established during the SI. As a result of these findings, the boundary was revised and the overall acreage of the former Mortar Range MRA was increased from a total of 291 acres to 322 acres. Based on the evidence of two distinct historical uses as a general troop training area and a training range, the former Mortar Range MRA (FGGM-003-R) was divided into the 62-acre Mortar Area (FGGM-003-R-01) and the 260-acre Training Area (FGGM-003-R-02) MRSs.

Based on discussions at the 12 June 2008 Technical Project Planning meeting and subsequent planning by the DoD, no future residential development is planned within the MRA boundary. Based on the 2011 Real Property Master Plan Update, the MRA is intended for future professional and industrial use (Atkins, 2011). Construction as part of the expansion of the secure DoD facility is currently underway for the majority of the MRA and its surroundings. A portion of the area will also be retained for open space use and a forested area.

2.3 Topography

The terrain at FGGM is low lying, with the highest elevation reaching 300 feet (ft) above mean sea level (amsl) on the northwest corner of the installation. The lowest elevation is 65 ft amsl and occurs within the Patuxent River channel at the southernmost tip of the property. Most of the installation slopes gradually to the south and southwest. Slopes exceeding 10 percent (%) are rare and occur primarily in pockets in the north-central and central parts of the installation and along stream corridors. The southern half of FGGM contains gradual slopes, generally measuring less than six %.

The former Mortar Range MRA slopes slightly radially from a topographic high in the northeastern portion of the site and to the southwest from a secondary topographic high in the central portion of the site. Elevations range from approximately 256 ft amsl in the northeastern portion of the former Mortar Range MRA to approximately 151 ft amsl in the southeast portion of the site (Berger/EA, 2004).

The majority of the former Mortar Range MRA overlaps a portion of the FGGM golf course, with deciduous forest and some coniferous trees interspersed between the golf greens. The golf course is a man-made feature covering the eastern portion of the former Mortar Range MRA. As of early 2012, construction of additional DoD buildings began on the area that had been the golf course and jogging trail. As mentioned previously, the golf course and jogging trail have been permanently closed.

The former golf course was designed and built after the former Mortar Range stopped operational activities; any fill material brought to the site for regrading (including building of mounds for tee boxes or greens) would have altered the natural topography. The topographic contours from the 1923 Special Military Map showing the range during

its operational period and current topographic contours were compared. The comparison identified areas that had gained or lost elevation; however, the comparison was inconclusive based on the limitations of the 1923 map. Limitations associated with interpreting and comparing the 1923 map to a current topographic map include the age of the map, its low resolution, and the fact that there is no U.S. Geological Survey (USGS) map of the same resolution and/or time period available to confirm its data. Additionally, the resolution of historical USGS topographic maps was not detailed enough to perform an adequate comparison (i.e., 20 ft contour intervals). Therefore, it is unknown how much, if any, fill material was brought to the site. It is also unknown if any soil was removed from the site, or the extent of grading that was done during the construction of the golf course.

2.4 Surface Water Hydrology

The former Mortar Range MRA lies within the drainage of the Little Patuxent River. Midway Branch is located approximately 700 ft east of the former Mortar Range MRA and flows south through Allen Lake (also identified as Soldier Lake) approximately 1.25 miles south of the subject site. Midway Branch eventually empties into the Little Patuxent River. One unnamed tributary is located in the southeast corner of the former Mortar Range MRA and flows southeast to join Midway Branch. Additional unnamed tributaries are located to the west and south of the former Mortar Range MRA and flow southwest toward the Little Patuxent River [USGS, 2002; U.S. Army Corps of Engineers (USACE), 2002]. However, these tributaries are impacted by development, and no current evidence of them remained during the RI field investigation. These streams are shown in **Figure 2-3.**

2.5 Geology

The former Mortar Range MRA, located in the Atlantic Coastal Plain Physiographic Province, is underlain by igneous and metamorphic crystalline rock of the Precambrian to early Cambrian ages. The bedrock surface dips to the southeast and is the lower confining layer for the overlying Potomac Group unconsolidated sediments, consisting of (oldest to youngest) the Patuxent, Arundel, and Patapsco Formations (Berger/EA, 2004).

The Patapsco formation is up to 400 ft thick and consists of gray, brown, and red variegated silts and clays with lenticular, cross-bedded, argillaceous, subrounded sands and minor gravels [Maryland Geological Survey (MGS), 1968]. The youngest, Patapsco Formation, is composed of an upper, a middle, and a lower unit. The upper Patapsco unit varies in thickness, up to 40 ft, and is distinguished by medium to fine, yellow-brown, orange-brown, and tan sand and silty-sand. The upper unit is underlain by the middle Patapsco unit, consisting of thick, tough, highly plastic, mottled, reddish-brown to light gray clay that provides the upper confining unit for the lower Patapsco aquifer. The middle unit typically occurs between one and 41 ft below ground surface (bgs) and can be as thick as 102 ft (Versar, 2001). The lower Patapsco unit is composed of medium-fine, silty-sand grading with depth to coarser sand (Mack et al.,

1986). The Arundel clay is up to 100 ft thick and consists of dark gray and maroon lignitic clays with abundant siderite concretions (MGS, 1968). The Patuxent Formation is up to 250 ft thick and consists of white or light gray to orange-brown, moderately sorted, cross-bedded, argillaceous, angular sands and subrounded quartz gravels with subordinate silts and clays (Berger/EA, 2004). Beneath these sediments lie the igneous and metamorphic crystalline rock of the Precambrian to early Cambrian ages. The bedrock surface dips to the southeast and is the lower confining layer for the overlying Potomac Group unconsolidated sediments.

2.6 Soils

The soils of the former Mortar Range MRA are loamy sands and sands of the Evesboro and Galestown series, loamy and clayey land of the Muirkirk-Evesboro series, silt loams of the Bibb-Iuka series, and loamy sand of the Downer series [United States Department of Agriculture (USDA), 1972]. Other areas on the former Mortar Range MRA include altered urban areas and cut-and-fill locations.

2.7 Hydrogeology

There are three distinct aquifers within the FGGM installation: the Patuxent Formation, the lower Patapsco unit, and the upper Patapsco unit. The Patapsco Formation is separated from the Patuxent Formation by the tough, hard, Arundel clay.

The USDA Soil Conservation Service, now the Natural Resources Conservation Service, indicates that the soil in the upper Patapsco unit is of high hydraulic conductivity[2] with high infiltration rates and lists permeabilities[3] ranging from two to 20 inches/hour (in/hr). Hydraulic conductivities were estimated to be as high as 8.5 in/hr in the upper Patapsco aquifer and 2.85 in/hr in the lower Patapsco aquifer. Observations of soil lithology the 2004 Environmental Baseline Survey (EBS) supported this, with the only exception being a dense, extremely light gray silty/clay and clayey/silt encountered intermittently in several borings. This clay is more indicative of the material comprising the middle Patapsco unit and has an estimated vertical hydraulic conductivity of up to 2.8×10^{-4} in/hr. This fine material has a considerably lower hydraulic conductivity and acts as a confining layer. Whether this layer is continuous across the former golf course has not been established during. Groundwater flow in the Patapsco aquifers is to the east/southeast. The Patuxent Formation is a confined aquifer that directly overlies the igneous and metamorphic crystalline bedrock and is confined above by the Arundel clay (Berger/EA, 2004).

---

[2] Hydraulic conductivity is a soil property that describes the ease with which the soil pores permit water (not vapor) movement.

[3] Permeability is the measure of the ability of a material to transmit fluids.

3. Site Summary

This section summarizes the previous investigations nature and extent of contamination, and the results of the former Mortar Range MRA qualitative explosive risk assessment. As of early 2012, the former Mortar Area MRS and a majority of the Training Area MRS are under construction. The northwestern portion of the Training Area MRS is DoD property and is developed with buildings and associated paved surfaces (i.e., roadways, parking lots, and walkways).

FGGM is a fenced, closed installation. Guards and surveillance at all entrances restrict access. Once inside the installation, numerous buildings and areas have restricted access and are guarded. The portion of the site that is DoD property is fenced and has additional security. The current construction on the majority of the MRA (the former golf course) is an expansion of the existing secure DoD facility. This facility will be fenced after the completion of construction.

3.1 Summary of Previous Investigations

Studies and investigations have been conducted at the former Mortar Range MRA to determine the presence of MEC and MC, as well as other environmental impacts. These studies include the *Final Closed, Transferring, and Transferred (CTT) Range and Site Inventory, Fort George G. Meade, Maryland* (Malcolm Pirnie, 2003), *Final Environmental Baseline Survey (EBS), Site M, Fort Meade, Maryland* (Berger/EA, 2004), and *Geophysical Survey of Possible Dump Sites and an Abandoned Cemetery Fort George G. Meade, Maryland* (Versar, 2004). A Historical Records Review (HRR) and an MMRP SI were conducted in 2006 and 2007, respectively. The MEC fieldwork for the MMRP RI was conducted from January to March 2008 and the MC fieldwork in January 2010. The Final RI Report was completed in September 2011. An IRP Preliminary Assessment (PA) / SI of Operable Unit 45/FGGM-95 that includes five areas of interest (AOIs) that overlap the former Mortar Range MRA is currently underway. Summaries of these previous studies are presented below.

3.1.1 Closed, Transferring, and Transferred Range and Site Inventory

In 2003, the Phase 3 Closed, Transferring, and Transferred (CTT) Inventory was completed for FGGM; the active and the BRAC property were inventoried separately. Six closed sites were identified within the active portion of FGGM during the CTT, including the former Mortar Range. The former Mortar Range was identified as a 59-acre parcel with known MEC (Malcolm Pirnie, 2003).

3.1.2 Environmental Baseline Survey

The 2004 EBS was conducted for Site M, which includes the former Mortar Range MRA, along with an area east of the former Mortar Range MRA (Berger/EA, 2004). The 2004 geophysical survey report includes information regarding geophysical detections at various locations within the former Mortar Range MRA (Versar, 2004).

Both of these investigations found significant subsurface anomalies within the former Mortar Range MRA (Berger/EA, 2004). Prior to the RI, these anomalies had not been investigated, so it was unknown if these metallic anomalies were related to the former use of the site as a range or to another source. The EBS report also states that spent bullets, dummy mortar rounds, and pieces of exploded hand grenades were found on the golf course during routine use/maintenance of the golf course (Berger/EA, 2004); however, these reports from the maintenance department could not be confirmed during the SI or RI. As no fragments of exploded hand grenades, or other evidence of the use of explosively configured munitions items were identified during the SI or RI field activities, the usability of this data is limited to what was field verified.

During the 2004 EBS, 32 subsurface soil and eight groundwater samples were collected. All soil and groundwater samples were analyzed for metals and explosives, the expected constituents from mortars. During the EBS, three explosives [trinitrotoluene (TNT), cyclotrimethylene trinitramine (RDX), and nitrobenzene] were detected in soil below the Regional Screening Levels (RSLs) for residential soils.[4]

Numerous metals were detected in the soil during the EBS and Limited Site Investigation (Berger/EA 2003) conducted as part of the 2004 EBS (provided as an appendix); however, no metals associated with the munitions suspected to be used at the MRA (antimony, copper, lead, mercury, magnesium, and zinc) were detected above regulatory screening criteria. Groundwater was collected via direct push technology during the EBS, and TNT was identified in two groundwater samples below the regulatory screening criteria for tap water. Metals were not detected above the regulatory screening criteria in groundwater at the site (Berger/EA, 2004; Malcolm Pirnie, 2007).

3.1.3 Historical Records Review

The HRR was conducted during 2006. The acreage remained unchanged from the Phase 3 CTT Inventory. The area was identified as forested land, a golf course, and parking areas. Suspected munitions identified at the site included 60mm and 81mm mortars and 3-inch and 6-inch Stokes mortars. In the 1990s, an Explosives Ordnance Disposal (EOD) unit had reported a live White Phosphorus round had been found near the golf course adjacent to Mapes Road. No field work was conducted as part of the HRR (Malcolm Pirnie 2006).

---

[4] TNT had a maximum detected value of 76 micrograms per kilogram (µg/kg) with an RSL of 3,600 µg/kg. RDX had a maximum detected value of 180 µg/kg with an RSL of 4,800 µg/kg. Nitrobenzene had a maximum detected value of 130 µg/kg with an RSL of 5,600 µg/kg.

3.1.4 Site Inspection

SI fieldwork was conducted at the former Mortar Range MRA in August 2006. A magnetometer-assisted site walk and visual site survey, covering approximately 21 acres of the site, focused on the undeveloped areas of the MRA to determine the presence of MEC in these locations. During the fieldwork, no MEC items or munitions debris was identified on the surface. Locations of subsurface metallic anomalies were not recorded during the SI site walk.

Ten composite surface soil samples and one duplicate were collected at the former Mortar Range MRA during the SI and analyzed for Target Analyte List metals and explosives. While arsenic exceeded the regulatory screening criteria for every sample, it did not exceed the FGGM background range. Several samples had above background detections of various other metals, but none of the other detections exceeded the RSLs. Silver was above background level for all five samples. Aluminum, antimony, cadmium, calcium, copper, and zinc were above background for one or more samples. Lead exceeded the background value in all 10 of the samples but was well under the USEPA action level for residential soil for lead. No explosives were reported above the laboratory detection limit (Malcolm Pirnie, 2007).

The former Mortar Range MRA SI boundary Surface Danger Zone overlaps a portion of the Pistol Range B MRS. Pistol Range B was investigated as part of the MMRP SI, and no evidence of its use as a former range was identified. As a result of the SI, no further action was approved for the Pistol Range B MRS (Malcolm Pirnie, 2007).

3.1.5 Remedial Investigation

The RI fieldwork was conducted in 2008 for MEC and 2010 for MC, and the results of that work were summarized in the RI Report for the former Mortar Range MRA (ARCADIS/Malcolm Pirnie, 2011).

As described in Section 3.1 of the RI Report, MEC fieldwork was conducted from January to March 2008 and included:

- a geophysical prove-out;
- location surveys and mapping;
- brush cutting and surface sweep;
- digital geophysical mapping (DGM) and evaluation, anomaly reacquisition, and marking;
- intrusive investigations and identification of selected anomalies identified during the geophysical mapping; and
- proper disposal of all recovered munitions debris and non-munitions debris material.

The geophysical investigation identified 6,228 anomalies within the portion of the site intrusively investigated by transects or step-out boxes (approximately 29 linear miles).

Of these, 1,805 were identified as cultural features. The 4,423 remaining anomalies were evaluated, and 1,333 anomalies were investigated during the intrusive investigation. A high amount of non-munitions-related scrap metal was identified at the site, such as horseshoes and nails. While no MEC (except small arms ammunition not presenting a unique explosive hazard) were found at the site, the following munitions debris was found: 60mm and 81mm training mortar rounds, 3-inch Stokes training mortar rounds, expended illumination mortars, training grenades, a dummy grenade, a training landmine, small arms ammunition, and expended flares. The training mortar rounds were concentrated in an area corresponding to the original mortar range location shown on maps from the 1920s (ARCADIS/Malcolm Pirnie, 2011). The locations of munitions debris are shown on **Figure 3-1.**

These training rounds were incorrectly classified as "practice" in the field. However, based on review of field photographs by unexploded ordnance (UXO) staff and an interview with an UXO Technician who was at the site, all of the items were determined to be training, not practice.

The discarded small arms ammunition is considered discarded military munitions (DMM) and, therefore, MEC. However, the DoD's explosives safety communities do not consider small arms ammunition as presenting a unique explosive hazard. The DoD Explosives Safety Board (DDESB) defines small arms ammunition as, "Ammunition, without projectiles that contain explosives (other than tracers), that is .50 caliber or smaller, or for shotguns". The discarded small arms ammunition found on the Mortar Area MRS was removed; however, the pit of expended 0.22-caliber (cal) short cartridge casings found on the Training Area MRS, were left in place per the direction of the USACE Ordnance and Explosives Safety Specialist (OESS).

The conceptual site model for the former Mortar Range MRA, as presented in the Work Plan, was updated based on the MEC fieldwork results. The historical aerial photographs and the MEC fieldwork results support that the surrounding area was used for general troop training. Thus, based on two distinct historical uses as a general troop training area and a training range, the former Mortar Range MRA (FGGM-003-R) was divided into the 62-acre Mortar Area MRS (FGGM-003-R-01) and the 260-acre Training Area MRS (FGGM-003-R-02) (ARCADIS/Malcolm Pirnie, 2011).

The results of the MEC investigation were used to tailor the MC investigation strategy. The MC fieldwork was conducted in January 2010 and included the collection of surface samples in accordance with the MC Work Plan Addendum. The munitions constituents of concern (MCOC) identified include a select set of metals (i.e., antimony, copper, lead, magnesium, mercury, and zinc), explosives (including nitroglycerin), and nitrocellulose (collected at the Mortar Area MRS only[5]) and were selected based on the munitions debris encountered during RI MEC field effort.

---

[5] Because firing points are believed to be within the Mortar Area MRS, propellants

At the Mortar Area MRS, twenty-seven surface soil samples were collected in a statistically random pattern. Field samples were biased, collected at the five locations on the Training Area MRS where munitions debris was found. Samples collected from the 2007 SI were also used in the qualitative analysis of MC in the 2011 RI Report (ARCADIS/Malcolm Pirnie, 2011). During the 2007 FGGM SI, five samples were collected each from the Mortar Area MRS and the Training Area MRS.

Data generated during the RI MEC and MC field investigations were used to assess the potential safety hazards and/or risks to enable selection of a cost effective and efficient response action. Since only small arms ammunition (not presenting a unique explosive hazard), munitions debris, no MEC fragments, and evidence of only training items with no explosive configuration were identified, no direct evidence of explosive risk was identified for the MRA. In accordance with the guidance provided in the USEPA's *Munitions and Explosives of Concern Hazard Assessment Methodology, Interim October 2008* (USEPA, 2008), given the lack of evidence of an explosive risk, the use of the MEC hazard assessment (MEC HA) methodology was deemed inappropriate for the MRA and a MEC HA was not prepared. However, given the historical use of the MRA as a mortar range and training area, a minimal residual risk of explosive hazard remains despite the physical evidence uncovered during the RI field activities. Therefore, a qualitative explosive risk assessment was conducted to assess potential risks associated with MEC and MPPEH. Human health and ecological risk assessments were conducted to assess potential risks associated with MC and were reported in the RI Report.

- The qualitative explosive risk assessment concluded that, based on the results of the 2011 RI, there is a low probability for human receptors to encounter MEC on the MRA.
- The HHRA concluded that, based on comparison of the maximum detected metals concentrations to chemical-specific RSLs, no Contaminants of Potential Concern were identified for the site. Therefore, there are no unacceptable human health risks associated with the MC.
- The SLERA concluded that adverse health effects in ecological receptors from exposure to MC in surface soil at the former Mortar Range MRA are not likely and no Contaminants of Potential Ecological Concern associated with MC metals were identified.

Therefore, based on the results of the RI, safety hazards associated with MEC and MPPEH exist at both the Mortar Area MRS and the Training Area MRS on the former Mortar Range MRA. Although the probability of MEC or MPPEH being encountered is low, the acute nature of the hazard warrants consideration of a munitions response action. Based on the result of the human health and ecological risk assessments no

---

(e.g., nitrocellulose) were considered MCOC at this site. No propellants were expected in the Training Area MRS; therefore, nitrocellulose was not sampled at the MRS.

further investigation or munitions response actions related to MC are warranted as there are no unacceptable risks.

An Munitions Response Site Prioritization Protocol (MRSPP) was prepared for the former Mortar Range MRA as part of the April 2007 MMRP SI Report for FGGM. Since additional data were collected, the MRSPP provided in the SI Report was re-evaluated and updated in the RI Report to reflect the current understanding of site conditions. The Mortar Area MRS and the Training Area MRS received overall site rating/priority of 7 and 8, respectively. These ratings represent the lowest relative priority for the Training Area MRS and the second lowest relative priority for the Mortar Area MRS.

3.1.6 Preliminary Assessment / Site Inspection, Golf Course Area of Interest

Currently the Army is in the process of evaluating several IRP sites co-located with the MRA and these sites are currently at the PA/SI stage. These sites are presented on **Figure 3-2.**

Prior to the PA/SI Work Plan, a desktop review was conducted of existing data at the site, ranging from 2003 to 2010. During the PA/SI, MCOC were detected above RSLs for subsurface surface soil and Maximum Contaminant Levels (MCL) for groundwater at three parcels within the Training Area MRS (URS, 2010). Mercury was found to be above the MCL for groundwater at Site M Parcel 2. Antimony was found to be above the MCL for subsurface soil and groundwater at Site M Parcels 7 and 8. Lead was found in subsurface soil at Parcels 2 and 8 above MCLs. However, these parcels were associated with former landfills or dumpsites, and as shown on **Figure 3-2** were well outside the boundary of the Mortar Area MRS within the Training Area MRS. Therefore, these concentrations were believed to be associated with dumping activities rather than munitions use (URS, 2010).

Based on the 2011 PA/SI Work Plan, five Site M Parcels within the former Mortar Range MRA were recommended for further action: Parcels 1, 2, 3, 7, and 8 (URS, 2010). One parcel (Parcel 4) within the Training Area MRS footprint was recommended for no further action (NFA).

During the 2011 PA/SI, four surface soil samples, six subsurface soil samples, and ten groundwater samples were collected. Based on the field work, AOIs 1, 2, 3, and 7 were recommended for NFA. AOI 8 was recommended for NFA for groundwater and was recommended for further action for subsurface soil (URS, 2012).

3.1.7 Munitions-Related Findings

On 16 December 2011, a 3-inch training Stokes mortar (no fuze) was encountered near the ground surface during tree clearing activities. The item was found within the boundaries of the Mortar Area MRS, as depicted on **Figure 3-2**. The USACE Ordnance Explosive Safety Specialist onsite when the item was encountered

indicated that this item was retained by the USACE for their future use as a training device. This item was consistent with items found during the RI field activities and with the historical use of the MRS.

On 8 February 2012, a 75-mm Mk1 shrapnel projectile with a Mk3A1 fuze was encountered approximately six feet below ground surface during excavation activities. The item was found within the boundaries of the Training Area MRS as depicted on **Figure 3-2**. Fort Meade Department of Emergency Services contacted the on duty EOD response team from Andrews Air Force Base. The item was blown-in place by the EOD response team from Andrews AFB, as it was too degraded to be moved. Based on the review of the EOD Report and photographs by an ARCADIS UXO Technician, it was determined that the item was not a training item and had never been fired. The Mk1 shrapnel projectile was developed in 1784 and was typically used up until the World War II timeframe consistent with the munitions debris uncovered during the RI field activities. Because the item was not consistent with historical site use (not a training item), it was determined that this was a discarded or abandoned item.

3.2 Nature and Extent of MEC/ MPPEH

A geophysical investigation was conducted as part of the RI. Different types of munitions debris were found in different parts of the former Mortar Range MRA, justifying splitting the site into two distinct MRSs. The only MEC found within the MRA was small arms ammunition (not presenting a unique explosive hazard) found on the Mortar Area MRS. The munitions debris found at each MRS is described below.

- Mortar Area MRS: 60mm and 81mm training mortar rounds, 3-inch Stokes training mortar rounds, expended illumination mortars, training grenades, a dummy grenade, a training landmine, small arms ammunition (MEC) , and expended flares.
- Training Area MRS: one expended illumination mortar, a training grenade, small arms ammunition, and expended flares.

The training mortar rounds were concentrated in an area corresponding to the original mortar range location shown on maps from the 1920s (ARCADIS/Malcolm Pirnie, 2011).

A pit of expended 0.22-cal short cartridge casings was found on the Training Area MRS. These casings were left in place per the direction of the USACE OESS.

The locations of munitions debris found at the Mortar Area MRS and Training Area MRS are shown on **Figure 3-1.**

3.3 Summary of the Risk Assessments

As stated in Section 3.1.5, the qualitative explosive risk assessment concluded that, based on the results of the 2011 RI, there is a low probability for human receptors to encounter MEC on either of the MRSs. Although the probability of MEC or MPPEH being encountered is low, the acute nature of the hazard warrants consideration of a munitions response action.

The HHRA concluded that, based on comparison of the maximum detected munitions-related metals concentrations to chemical-specific RSLs, no Contaminants of Potential Concern were identified for the training activities conducted at the Mortar Range MRS or the Training Area MRS. Therefore, there are no unacceptable human health risks associated with the MC.

The SLERA concluded that adverse health effects in ecological receptors from exposure to MC in surface soil are not likely at either of the MRSs, and no Contaminants of Potential Ecological Concern associated with MC metals were identified.

Based on the results of the risk assessments, it was determined that the probability for humans to encounter MEC or MPPEH on both MRSs is low, and, therefore, the same remedial alternatives are applicable to both MRSs. Therefore, the two MRSs will be evaluated concurrently in this document to avoid redundancy.

4. Remedial Action Objectives

The purpose of the FFS is to identify, develop, evaluate, and recommend a remedial alternative that mitigates, to acceptable levels, potential risks to human and ecological receptors for current and reasonably anticipated future land use for the Mortar Area MRS and Training Area MRS within the former Mortar Range MRA. This section presents the RAOs, and establishes the Remediation Goals (RGs). RAOs are site-specific, initial clean-up objectives that are established on the basis of the nature and extent of impacts, the resources that are currently and potentially threatened, and the potential for human and ecological exposure. Because it has been determined that the hazards are the same for both MRSs, the RAOs will be the same for both MRSs.

4.1 Identification of Hazards

Based on the results of the RI, MEC / MPPEH safety hazards, albeit low, exist at both the Mortar Area MRS and the Training Area MRS on the former Mortar Range MRA. Although the probability of MEC or MPPEH being encountered is low, the acute nature of the hazard warrants consideration of a munitions response action for both MRSs. Based on the result of the human health and ecological risk assessments no further investigation or munitions response actions related to MC are warranted as there are no unacceptable risks.

4.2 Scope of the Remedial Action

Based on past investigations, MEC / MPPEH risks, while a low probability based on the extensive RI, do exist at both the Mortar Area MRS and the Training Area MRS on the former Mortar Range MRA. Explosive risks from MEC / MPPEH must be eliminated or controlled on both MRSs to mitigate the acute physical hazard posed to current and future site users.

4.3 Identification of Applicable or Relevant and Appropriate Requirements

4.3.1 Definition of Applicable or Relevant and Appropriate Requirements

The NCP and Section 121 of the CERCLA require that CERCLA remedial actions attain federal and state ARARs when determined to be applicable or both relevant and appropriate, unless specific waivers are granted. State ARARs must be attained under Section 121(d) of CERCLA, are they are legally enforceable and consistently enforced statewide. In addition to ARARs, other guidance and regulations may be classified as guidance "to be considered" (TBC) (USEPA, 2004).

Potential ARARs and TBCs are identified in this section to aid in development of remedial actions and in establishment of required cleanup levels. Additionally, ARARs and TBCs are used to scope and formulate remedial action alternatives and to govern implementation and operation of the selected remedial alternatives (USEPA, 2004).

Discussions of ARARs and TBC criteria are provided as follows:

- **Applicable Requirements.** Applicable requirements refer to those federal or state requirements that are legally enforceable. An example of an applicable requirement would be the Safe Drinking Water Act's Maximum Contaminant Levels for a site that contaminates a public drinking water supply.
- **Relevant and Appropriate Requirements.** Relevant and appropriate requirements are federal or state standards, criteria, or guidelines that are legally enforceable at a site. While not "applicable", their application is appropriate because they address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well-suited to the particular site. Relevant and appropriate requirements have the same weight and consideration as applicable requirements. An example of relevant and appropriate requirements might be state groundwater protection levels established for other regulatory programs such as the Underground Storage Tank program or Resource Conservation and Recovery Act (RCRA) Subtitle D.
- **TBC.** Other federal and state recommended standards or criteria applicable to a specific site that are not generally enforceable but are advisory are categorized as TBC. For example, where no specific ARAR exists for a chemical or situation, or where such an ARAR is not sufficient to be protective of human health or the environment, federal and/or state guidance or advisories may be considered in determining the necessary level of cleanup for the protection of public health and the environment. An example of a TBC is the use of USEPA risk screening criteria or USEPA Health Advisories for specific chemicals in determining action or cleanup levels.

4.3.2 Development of ARARs and TBCs

ARARs and TBCs are developed on a site-specific basis. ARARs and TBCs are further categorized as chemical-specific, location-specific, or action-specific. CERCLA actions may have to comply with them as follows:

- **Chemical-Specific.** Chemical-specific requirements define acceptable exposure levels for specific hazardous substances and, therefore, may be used as a basis for establishing preliminary remediation goals and cleanup levels for chemicals of concern in the designated media. Chemical-specific ARARs and TBCs are also used to determine treatment and disposal requirements for remedial actions. In the event a chemical has more than one requirement, the more stringent of the two requirements will be used.
- **Location-Specific.** Location-specific requirements set restrictions on the types of remedial actions that can be performed based on site-specific characteristics or location. Alternative remedial actions may be restricted or precluded based on federal and state laws for hazardous waste facilities or proximity to wetlands, floodplains or man-made features, such as existing landfills, disposal areas, and local historic landmarks or buildings.
- **Action-Specific.** Action-specific requirements set controls or restrictions on the design, implementation, and performance of remedial actions. They are triggered by the particular types of treatment or remedial actions that are selected to accomplish the cleanup. After remedial alternatives are developed, action-specific ARARs and TBCs that specify remedial action performance levels, as well as specific contaminant levels for discharge of media or residual chemical levels for media left in place, are used as a basis for assessing the feasibility and effectiveness of the remedial action.

4.3.3 Identification of ARARs and TBCs

4.3.3.1 Chemical-Specific ARARs and TBCs

During the EBS, three explosives (TNT, RDX, and nitrobenzene) were detected in soil below the USEPA regulatory screening criteria, and TNT was detected in groundwater below regulatory screening criteria; however, no explosives were detected during the subsequent SI or RI. Based on the results of the human health risk assessment and SLERA conducted during the 2011 RI, no further investigation of human health or ecological risks were warranted. Therefore, no chemical-specific ARARs or TBCs were identified for this project.

4.3.3.2 Location-Specific ARARs and TBCs

No Location-specific ARARs or TBCs were identified for this project, based on specific site characteristics or location.

4.3.3.3 Action-Specific ARARs and TBCs

Table 4-1 lists the action-specific regulations that are ARARs or TBCs to the evaluated response actions.

4.4 Remedial Action Objectives

The RAO for both the Mortar Area MRS and the Training Area MRS is based on the continued management of safety hazards associated with the potential for MEC / MPPEH.

The proposed RAO for the two MRSs included in this FFS is:

- Control and minimize the potential for contact with possible MEC / MPPEH at the surface and within the subsurface.

As discussed in Section 3.1.5, although no MEC was identified on the MRA during the RI, given the historical use of the MRA as a former training area and training range, a minimal residual risk of explosive hazard remains despite the physical evidence uncovered. It is important to note that once a MEC source area is identified, there will always be a residual risk of exposure regardless of the remedial action chosen. The limit of technology for the detection and removal of MEC, combined with the nature of the hazard (explosive), results in a residual risk that must be considered when selecting a remedial action.

4.5 Identification of Remediation Goals

RGs for MEC / MPPEH are to control the specific exposure pathways identified at the Mortar Area MRS and the Training Area MRS. Exposure pathways for MEC include contact by humans and ecological receptors.

5. Development of Remedial Action Alternatives

This section presents the remedial alternatives developed for the Mortar Area MRS and Training Area MRS based upon data collected during the all previous field activities at the former Mortar Range MRA. As presented in the RI / Feasibility Study guidance section of Engineer Pamphlet (EP) 1110-1-18, the natural characteristics of a particular site may limit the technologies that may be used. There are "cases where there may be so few realistic options that a screening process is not needed and only a detailed analysis is conducted" (USACE, 2006). Due to the limited number of appropriate technology types and alternatives for MEC only remedial actions, a limited number of remedial alternatives can be developed to meet the project RAO.

Three munitions remedial alternatives were developed for potential implementation at the two MRSs within the former Mortar Range MRA. The alternatives represent a reasonable range of alternatives that meet the requirements of EP-1110-1-18 (USACE, 2006). The following remedial alternatives have been developed for the two MRSs within the former Mortar Range MRA:

- Alternative 1: No action
- Alternative 2: Land use controls (LUCs) with long term management (LTM)
- Alternative 3: Surface and subsurface removal, LUCs, and LTM

Since the results of the 2011 RI indicated there is a low probability for human receptors to encounter MEC at both MRSs; the same alternatives are applicable to both MRSs. Therefore, the alternatives for each MRS will be analyzed concurrently.

A description of each alternative is provided in the following sections.

5.1 Alternative 1 – No Action

Alternative 1 involves taking no munitions response action at the Mortar Area MRS or the Training Area MRS. No MEC / MPPEH will be removed from either MRS, and noLUCS would be implemented. Alternative 1 serves as the baseline against which the effectiveness of other alternatives is judged. This alternative does not meet the RAO outlined in Section 4. This alternative is required under the NCP but is not considered to be effective at addressing and controlling the hazards associated with potential MEC / MPPEH at the site.

5.2 Alternative 2 – Land Use Controls with Long Term Management

Under Alternative 2, existing LUCs at the sites will be maintained and enhanced. LUCs are defined broadly as legal measures that limit human exposure by restricting activity, use, and access to properties with residual contamination. The two types of LUCs will be used: institutional controls (IC) and engineering controls (ECs). ICs are administrative measures put in place to restrict human activity, in order to control future land use. ECs include a variety of engineered constructed barriers to restrict human

activity, in order to control future land use. The LUCs are incorporated into the master plan and included in the installation's Geographical Information System (GIS). Alternative 2 will minimize and control exposure to MEC / MPPEH on the surface or in the subsurface soil.

The four general categories of ICs evaluated or already in use at FGGM, and which provide layers of protection, are as follows: governmental controls, proprietary controls, enforcement and permitting, and informational devices, which assist with the management and implementation of LUCs (USEPA, 2000b; USEPA, 2010). Most of these measures are already in place as elements of required procedures at FGGM. These elements include requirements to obtain dig permits from the Directorate of Public Works for any intrusive activity at FGGM; Master Plan Regulations; and FGGM GIS Database. These existing requirements are detailed below. These controls have been developed with a consideration of all reasonably anticipated land uses at FGGM; these include administrative and industrial military operations, open space, and a forested area. These IC's would be formalized into CERCLA required procedures at the former Mortar Range MRA. ICs would be supplemented by the requirement for UXO Construction Support for all intrusive Military Construction projects, and UXO avoidance procedures for any other intrusive activity. Because the Mortar Area MRS and Training Area MRS are both considered low probability sites for MEC / MPPEH, an Explosive Safety Submission or Explosive Site Plan is not required. Additionally an education program will be initiated for construction workers, potential future site workers, and emergency responders of the MRA.

No future residential development is planned within the MRA boundary. Residential land use at the former Mortar Range MRA will be prohibited as part of LUCs. This will be updated in the Master Plan.

ECs, including MRS-specific signage describing restrictions of site use at key locations of the site, will be installed. Annual inspections will be performed to establish that all on-site LUCs (e.g., MRS-specific signage) are in good condition, to confirm that the land use of the site has not changed, and to confirm through instrument-assisted surface sweep that no MEC / MPPEH/ munitions debris has been exposed through erosion or frost heave. If MEC /MPPEH / munitions debris is observed during the annual inspections, EOD will be contacted to remove and properly dispose of the item(s).

The LTM process will be added as part of the LUCs. The five-year review process and the annual land use certifications/surface sweeps will be used to document continuing land use is industrial and the remedy remains protective. Additionally, the remedial design will specify notification requirements to the USEPA should land use change occur, or be planned.

The following ICs are already in place at FGGM:

- **Master Plan Regulations, Army Regulation (AR) 210-20**: The Army issued a new regulation, Master Planning for Army Installations, AR 210-20, on 13 July 1987 updating an earlier regulation dated 27 January 1976. AR 210-20 "establishes the requirement for an installation master plan and planning board and specifies procedures for developing, submitting for approval, updating, and implementing the installation master plan." This regulation provides for comprehensive planning at Army installations and not only allows, but requires incorporation of existing land-use and conditions into the master plan. The master plan regulations provide a framework for comprehensive planning through the use of component plans, which include, but are not limited to, the following:

    - Natural Resources Plan;
    - Environmental Protection Plan;
    - Installation Layout Vicinity Plan;
    - Land-use Plan; and
    - Future Development Plan.

The overall objective is to provide each installation with a master plan through the integration of each component plan into the installation master plan. The component plans form a series of narrative, tabular and graphic plans. Their integration into an installation master plan provides many benefits as outlined in AR 210-20, including "the mechanism for ensuring that installation projects are sited to meet operational, safety, physical security, and environmental requirements."

- **FGGM GIS Database:** FGGM maintains a comprehensive installation-wide GIS database. The database includes descriptions of existing land and environmental restrictions, locations of known contamination, and locations of MRAs / MRSs. This information will allow future end-users and tenants of FGGM to make rapid and accurate inquiries regarding sites within FGGM and will specify the LUCs in-place at specific locations. Existing wells, chemical contamination, building restrictions, MEC concerns, and many other lines of inquiry, will quickly be available to support the decision making process.

- **FGGM Access Regulations**: Access regulations are in place at FGGM. Although not closed to the public, access to FGGM is strictly controlled. Trespassing and unauthorized activities on FGGM are illegal.

- **Army Military Construction Program Development and Execution**: Army regulation AR 415-15 outlines pre-construction environmental survey procedures. Prior to construction activities, the Army categorizes the proposed construction site based on an environmental survey. Under this regulation, the Army must determine wetland status of the site, historical significance, and endangered species habitat identification.

As described previously, a pit containing several thousand expended 0.22-cal short cartridge casings was identified on the Training Area MRS during the RI fieldwork. The expended 0.22-cal short cartridge casings were left in place per the direction of the USACE OESS. The casings do not pose an explosive hazard, and adjacent soil samples were evaluated during the RI MC investigation and showed no impact to soils. The casings will be recovered and recycled as scrap metal or properly disposed of prior to the implementation of Alternative 2 for the Training Area MRS. This will be done as a preliminary maintenance activity to prepare the MRS for the LUC program. The costs associated with this maintenance activity are negligible and have been included in the costs analyses for Alternative 2.

Consistent with CERCLA guidance, and for the purpose of comparison, the cost estimate for this alternative has been prepared to assume that LUCs with LTM, including annual certification, would be maintained for 30 years.

5.3 Alternative 3 –Surface and Subsurface Removal with LUCs with LTM

Alternative 3 will include MEC / MPPEH clearance within the surface and the subsurface of the MRA; and LUCs with LTM, as described in Section 5.2.

The clearance will include location surveys, brush cutting, and a surface sweep throughout both the Mortar Area MRS and the Training Area MRS prior to the start of MEC activities. DGM will be conducted in all accessible areas, and “mag and flag” will be used in small patches of grass between buildings in the northwestern portion of the site. All mapped items will be removed to equipment detection depth.

Should any MEC / MPPEH items found on site be safe to move, these items will be consolidated and demolition operations conducted in a remote portion of the current construction area to reduce the number of demolition shots and impacts on nearby Installation mission activities. If they cannot be moved, the items will be blown-in place. Munitions debris will be handled under chain-of-custody protocols, flashed to 5X, and properly disposed of or recycled. The expended 0.22-cal short cartridge casings will be recovered and recycled as scrap metal or properly disposed of as part of Alternative 3. Non-munitions-related scrap will be removed from site and properly disposed or recycled.

It is important to note that limitations of technology for the identification and removal of MEC / MPPEH on site will result in a residual MEC risk. Due to this small but possible residual MEC / MPPEH hazard after the removal action, LUCs will still need to be put in place to effectively control and prevent explosive hazard exposure to potential human receptors. The proposed LUCs have been described under Alternative 2.

6. Detailed Evaluation of Remedial Alternatives

This section presents and applies evaluation criteria to perform detailed comparative analyses of the remedial alternatives developed in the previous section. These analyses are performed to aid in the selection of the remedial alternative that best satisfies the criteria identified in the NCP and the specific RAO, ARARs, and RG for the Mortar Area MRS and the Training Areas MRS. As stated previously, based on the results of the RI, it was determined that the probability for humans to encounter MEC or MPPEH on both MRSs is low and, therefore, the same remedial alternatives are applicable to both MRSs. The two MRSs were, therefore, evaluated concurrently to avoid redundancy.

6.1 Evaluation Criteria

Section 300.430(e) of the NCP lists nine criteria against which each remedial alternative must be assessed. The first two criteria are threshold criteria that must be met by each alternative. The next five criteria are the primary balancing criteria upon which the analysis is based. The final two criteria are referred to as modifying criteria and are applied after the subsequent public comment period on the Proposed Plan to evaluate state and community acceptance. These two criteria are described in the Decision Document. The acceptability or performance of each alternative against the criteria is evaluated individually so that relative strengths and weaknesses may be identified.

The two threshold criteria are:

- Protection of human health and the environment; and
- Compliance with ARARs.

The five primary balancing criteria upon which the analysis is based on are:

- Long-term effectiveness and permanence;
- Reduction of toxicity, mobility, or volume through treatment;
- Short-term effectiveness;
- Implementability; and
- Cost.

As stated earlier, the modifying criteria are not addressed in this FFS but are addressed in the Proposed Plan. These criteria are:

- State acceptance; and
- Community acceptance.

6.1.1 Overall Protection of Human Health and the Environment

This criterion addresses whether a remedial alternative will achieve adequate protection of human health and the environment and describes how MEC will be eliminated, reduced, or controlled at both MRSs through treatment, engineering, and/or LUCs. Because there is not an established threshold for MEC hazard, the goal is to effectively minimize or eliminate the exposure pathway between the MEC and receptor.

6.1.2 Compliance with ARARs

Addresses whether a remedial alternative meets all ARAR selected federal and state environmental statutes and regulations. To be acceptable, an alternative shall comply with ARARs or be covered by a waiver.

6.1.3 Long-Term Effectiveness and Permanence

This criterion addresses the ability of a remedial alternative to maintain reliable protection of human health and the environment over time. It considers the magnitude of residual hazard, the adequacy of the response in limiting the hazard, and whether LUCs and LTM are required.

6.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment

This criterion relates to the extent to which the remedial alternatives permanently reduce the volume of MEC / MPPEH / munitions debris and reduces the associated safety hazard of MEC / MPPEH. Factors for this criterion include the degree of permanence of the remedial action, the volume removed / demolished / rendered safe, and the type and quantity of MEC / MPPEH / munitions debris remaining.

6.1.5 Short-Term Effectiveness

Short-term effectiveness addresses the period of time needed to implement the remedy and any adverse impacts that may be posed to workers, the community, and the environment during implementation. MEC / MPPEH removal poses risks to workers and the public during these activities that must be considered and controlled.

6.1.6 Implementability

The technical and administrative feasibility of implementing each alternative and the availability of services and materials are addressed by this criterion. This criterion also considers the degree of coordination required by the regulatory agencies, successful implementation of the remedial action at similar sites, and research to realistically predict field implementability.

6.1.7 Cost

This criterion addresses the capital costs, the operation and maintenance (O&M) costs, and the present worth analysis of costs anticipated for implementation of the response action. Capital costs are divided into direct costs for construction and indirect costs for non-construction and overhead. Direct capital costs include construction, equipment, relocation, disposal, and land and site development costs. Indirect capital

costs include engineering expenses, legal fees, license or permit costs, start-up costs, and contingency allowances. O&M costs consist of costs associated with post-construction activities necessary to properly operate, maintain, and monitor a given response action.

A detailed present worth cost is developed for each alternative. The cost estimates presented in this FFS have been developed in accordance with USEPA guidance (USEPA, 2000a), engineering experience with comparable sites, and previous project costs. The cost estimates presented in this report were prepared with an anticipated accuracy range of -30 to +50 percent.

6.1.7.1 Direct Capital Cost

Direct capital costs are comprised of the following components:

- Construction costs - Costs for materials, labor, and temporary equipment necessary to implement the alternative;
- Equipment costs - Cost of the equipment and/or services necessary to implement the response action; these are permanent equipment costs that continue for the duration of the operational period; and
- Disposal/demolition costs - Costs for the demolition of MEC / MPPEH or disposal of wastes generated during any additional investigations, remediation, and monitoring activities.

6.1.7.2 Indirect Capital Cost

Indirect capital costs are comprised of the following components:

- Engineering expenses - Costs for project administrative, design, and construction supervision;
- Legal fees and license or permit costs - Administrative, legal, and technical support costs to obtain licenses and permits for installation and operation of the response action; and
- Contingency allowances - Funds allocated and budgeted to cover unforeseen circumstances or scope modifications.

6.1.7.3 Operation and Maintenance Cost

O&M costs are comprised of the following components:

- Operating labor costs - Wages, salaries, overhead, fringe benefits, and profit associated with the labor force required to implement O&M operations;
- Administrative costs - Costs associated with administration of the response action operations, including financing, accounting, and general overhead and management;

- Insurance, taxes, and licensing costs - Costs such as liability and sudden accident insurance, licensing fees, or permit renewal and reporting costs;

- Maintenance Reserve and Contingency Funds - Costs for the anticipated replacement or rebuilding of equipment or unanticipated O&M costs; and

- Other Costs - Items not otherwise assignable to the above categories.

6.2 Analysis of Alternatives

This section includes individual and comparative analyses of the alternatives proposed for the Mortar Area MRS and Training Area MRS with respect to the seven evaluation criteria described in Section 6.1. The quantitative analysis of remedial alternatives is summarized in **Table 6-1,** and the remedial cost summary is summarized in **Table 6-2**.

6.2.1 Individual Analysis of Alternatives

The individual analysis of alternatives consists of an evaluation and assessment of the proposed alternatives with respect to the criteria described in Section 6.1.

6.2.1.1 Alternative 1 - No Action

Alternative 1 is the no-action remedial alternative for the Mortar Area MRS and the Training Area MRS. Under this alternative, no further effort or resources would be expended at the site. The summary of Alternative 1 compared to the NCP criteria is presented below and in **Table 6-1**.

- Overall Protection of Human Health and the Environment: The no action alternative does not meet the threshold factor since no action would be taken to control or reduce the risk of potential receptor exposure to MEC / MPPEH. Thus, Alternative 1 does not meet this criterion for overall protection of human health and the environment.

- Compliance with ARARs: ARARs are not identified for the no action alternative in accordance with guidance from the USEPA Office of Solid Waste and Emergency Response Directive 9234.2-01/FS-4, ARARs Question and Answers (USEPA, 2004).

- Long-Term Effectiveness and Permanence: The no action alternative does not provide any precautions to control or reduce potential contact risks for MEC / MPPEH. All current and potential future risks would remain the same under this alternative. Thus, Alternative 1 does not meet this criterion for long-term effectiveness and permanence.

- Reduction of Toxicity, Mobility, or Volume through Treatment: This alternative does not employ an action that will result in a permanent solution for the site. The volume of MEC / MPPEH / munitions debris would not be reduced with Alternative 1 since no action would be taken, nor would explosive hazard from MEC / MPPEH as related to control of exposure be reduced.

- Short-Term Effectiveness: Implementation of this alternative does not pose any additional risks to the community, the workers, or the environment since there are no remedial activities associated with it; however, it does not mitigate any existing or potential future risks.

- Implementability: There are no implementability concerns posed by this option.

- Cost: There are no present worth costs and capital costs for the no action alternative because there would be no action taken. Costs for this alternative are in **Table 6-2.**

6.2.1.2 Alternative 2 – LUCs and LTM

Alternative 2 requires that the existing LUCs are formalized as a CERCLA action as well as additional LUCs to be implemented. The Installation Master Plan will be modified to note the area where intrusive activity is to be controlled and MRS-specific signage to be installed around the site warning of site hazards. An educational program for construction workers, potential future site workers, and emergency responders would be implemented to warn of the potential explosive hazards associated with each MRS. In addition, controls would be placed on intrusive activities to supplement the well-established dig permit procedures already in place at FGGM. This would be accomplished by revising the established dig permit process to require UXO construction support for all intrusive activities occurring on the MRA. Because there is a potential for MEC / MPPEH / munitions debris resurfacing through mechanisms such as erosion or frost heaves, LTM will be put into place. LTM will include an annual LUC inspection/surface sweep, annual reporting of the results, and five-year reviews to ensure the remedy remains protective. If MEC / MPPEH / munitions debris is observed during the annual inspections, EOD will be contacted to remove and properly dispose of the item(s).

Prior to implementing Alterative 2 the expended 0.22-cal short cartridge casings will be recovered and recycled as scrap metal or disposed of properly. This will be done as a preliminary maintenance activity to prepare the Training Area MRS for the LUC program.

- Overall Protection of Human Health and the Environment: Alternative 2 meets these threshold criteria and would provide for reasonable protection to potential human receptors based on the results of the RI field activities and future anticipated land use of the site. MEC density across the former Mortar Range MRA is considered low based on the RI field activities; the site is already compatible with future use. Since the planned future land use at the former Mortar Range MRA involves intrusive construction over portions of the site, the low level MEC / MPPEH safety hazards would be specifically managed by LUCs through the continuation of installation-wide dig permits calling for on-site UXO construction support during all construction activities. The remaining LUCs (MRS-specific signage) would also limit exposure from unauthorized personnel by preventing and/or discouraging access. Furthermore, the LUCs would include educational programs to inform construction workers, potential future site workers, and emergency responders of the possible hazards at both MRSs. Additionally, LTM will be put into place limiting exposure to MEC / MPPEH on the surface in the future. Five-year reviews would also be put into place to ensure the remedy remains effective.

- Compliance with ARARs: Chemical- and location-specific ARARs are not applicable for this project. Action-specific ARARs would be met by this alternative, through the characterization and isolation of MEC / MPPEH safety hazards.

- Long-Term Effectiveness and Permanence: Alternative 2 can be effective over the long-term, because it provides continued control of the exposure pathway between MEC / MPPEH and the receptor populations through LUCs. Alternative 2 also limits the potential for future exposure to MEC on the surface through annual surface sweeps/inspections.

- Reduction of Toxicity, Mobility, or Volume through Treatment: Alternative 2 would not reduce the volume of MEC / MPPEH / munitions debris at either the Mortar Area MRS or the Training Area MRS, but it would reduce the effective explosive hazard from MEC / MPPEH through ICs and ECs by controlling access to the MRSs. Based on the nature of the hazard (explosive), residual MEC / MPPEH risk will remain on site regardless of which remedial alternatives are implemented. LUCs and LTM are typically the best ways to manage residual risk from potential MEC / MPPEH.

- Short-Term Effectiveness: Implementation of this alternative does not pose any additional short-term risks to the community, the workers, or the environment since there are no heavily intrusive remedial activities associated with it.

- Implementability: Alternative 2 can be implemented easily by hosting education meetings with construction workers, potential future site workers, and emergency responders. Other easily implementable LUCs that will be used at the site include the continuation of current site access restrictions (i.e., security controlled access gate on a portion of the Training Area MRS); MRS-specific signage; and updates to the Installation Master Plan and dig permits prohibiting any intrusive activities onsite without on-site UXO construction support. These are all easily implementable and can be completed in a timely fashion.

- Cost: Costs for the remedial action are in **Table 6-2**. Total cost for this alternative is approximately $342,000. Data supporting the cost estimates are presented in Appendix A. Overall; Alternative 2 is a relatively low cost, easily implementable alternative.

6.2.1.3 Alternative 3 –Surface and Subsurface Removal, with LUCs, and LTM.

Alternative 3 consists of conducting, to the extent possible, a surface and subsurface removal at the former Mortar Range MRA and implementation of the same LUCs and LTM described in Alternative 2. Location surveys, brush cutting, and a surface sweep throughout the MRSs will be conducted prior to the start of activity. DGM will be conducted in all accessible areas, and “mag and flag” will be used in small patches of grass between buildings in the northwestern portion of the site. All mapped items will be removed to equipment detection depth (approximately four ft bgs).

If the MEC (and MPPEH classified as MEC) items found on site can be moved, these items will be consolidated and demolition operations conducted in a remote portion of the installation to reduce the number of demolition shots. If they cannot be moved, the items will be blown-in place. MPPEH classified as munitions debris and non-munitions-related scrap will be removed from the site and properly disposed.

The expended 0.22-cal short cartridge casings will be recovered and recycled as scrap metal or properly disposed of as part of Alternative 3.

Alternative 3 requires that the existing LUCs are formalized as a CERCLA action as well as additional LUCs to be implemented. The Installation Master Plan will be modified to note the area where intrusive activity is to be controlled and MRS-specific signage to be installed around the site warning of site hazards. An educational program for construction workers, potential future site workers, and emergency responders would be implemented to warn of the potential explosive hazards associated with the site. In addition, controls would be placed on intrusive activities to supplement the well-established dig permit procedures already in place at FGGM. This would be accomplished by revising the established dig permit process to require UXO construction support for all intrusive activities occurring on the MRSs. Current security measures already in place at the former Mortar Range MRA would continue. Additionally, because there is a risk of MEC / MPPEH / munitions debris resurfacing through mechanisms such as erosion or frost heaves, LTM will be put into place. LTM will include an annual LUC inspection/surface sweeps, annual reporting of the results, and five-year reviews to ensure the remedy remains protective.

- Overall Protection of Human Health and the Environment: Alternative 3 meets the threshold criteria and would provide reasonable protection to potential human and ecological receptors since MEC / MPPEH would be removed to equipment detection depth (up to four ft bgs). However, due to the intrusive nature of the removal activities Alternative 3 would significantly impact the environment due removal of ecological habitats during implementation. LUCs would still be required for residual risk management. The subsurface MEC risks would be specifically managed by LUCs through installation-wide dig permits for on-site UXO construction support during construction activities. The Installation Master Plan will be modified to note the area where intrusive activity is to be controlled. The remaining LUCs (MRS-specific signage) would limit exposure from unauthorized personnel by preventing and/or discouraging access. The LUCs would include educational programs to inform potential construction workers, potential future site workers, and emergency responders of the possible hazards at the Mortar Area MRS and the Training Area MRS. Additionally, LTM will be put into place limiting future exposure to MEC / MPPEH on the surface to address the long term residual risk.

- Compliance with ARARs: Chemical- and location-specific ARARs are not applicable for this project. Action-specific ARARs would be met by this alternative, through the characterization and removal of MEC / MPPEH safety hazards. Any additional MEC / MPPEH / munitions debris found during the removal action would also meet ARARs, as the items will be characterized during the removal action.

- Long-Term Effectiveness and Permanence: Alternative 3 would be effective over the long-term because it would remove MEC / MPPEH from the surface and subsurface of the site, which limits the direct exposure pathway. This alternative cannot be considered a permanent solution primarily because of the uncertainty associated with MEC remediation and the acute hazard. LUCs and LTM would be required to increase effectiveness.

- Reduction of Toxicity, Mobility, or Volume through Treatment: Alternative 3 would substantially remove the volume of MEC / MPPEH / munitions debris at the former Mortar Range MRA on the surface and in the subsurface (up to four ft bgs).

- Short-Term Effectiveness: There would be a significant short-term risk to site workers associated with the surface clearance and subsurface removal activities. Elevated risk can be attributed to handling and disposal of MEC / MPPEH during these removal activities. By policy the Army includes the assessment of worker safety when evaluating munitions remedial alternatives with the objective of minimizing the number of people exposed to MEC; minimizing the number of MEC handled; and minimizing the amount of time spent handling MEC. However, the increase in short-term risk will lead to greater short- and long-term effectiveness.

- Implementability: Alternative 3 can be implemented using conventional MEC surface clearance, subsurface removal techniques along with LUCs and LTM. However, Alternative 3 presents considerable implementation challenges due to the need to remove vegetation across the MRA and clear thousands of isolated anomalies across a broad area. Alternative 3 will take approximately a year to implement. This would impact the building schedule for this property, as ground breaking is scheduled to take place in FY13.

- Cost: Costs for the remedial action are presented in Table 6-2. Total costs for this alternative are high at approximately $6.8 million. Data supporting the cost estimates are presented in Appendix A.

6.2.2 Comparative Analysis of Alternatives

The comparative analysis of alternatives includes an evaluation of the expected performance of each alternative relative to the other alternatives with respect to the seven criteria described in Section 6.1. The objective of this analysis is to identify the respective advantages and disadvantages of the alternatives.

In order to compare the alternatives quantitatively, general ratings have been assigned to the alternatives for each of the evaluation criteria, based on a subjective appraisal of the degree to which the alternatives meet the criteria. An overall rating for each alternative has been developed based on the individual criteria ratings, as presented in **Table 6-1**. The ratings in this table are on a scale of one to three, with three being the most favorable, and the highest overall score being the most favorable option.

- Overall Protection of Human Health and the Environment: Alternative 1 does not meet the threshold criteria since MEC is potentially located at the site and no action would be taken to control or eliminate the exposure pathway to receptor populations; thus, it is not protective of human health and the environment. Additionally, Alternative 1 does not meet the RAO. Both Alternatives 2 and 3 are protective of human health and the environment because they reduce the explosive hazard of potential receptor exposure to MEC through LUCs. Alternative 3 also would reduce the volume of potential MEC / MPPEH / munitions debris on-site but would significantly impact the environment as a result of the intrusive nature of the removal activities.

- Compliance with ARARs: ARARs are not identified for the no action alternative. Alternatives 2 and 3 would comply with action-specific ARARs identified with the former Mortar Range MRA; however, impacts to erosion control would have to be carefully addressed under Alternative 3 to ensure compliance with Action-specific ARARs.

- Long-Term Effectiveness: Alternative 1 does not meet this balancing criterion because no actions would be taken in the long-term to offer protection. Alternatives 2 and 3 both offer long-term effectiveness for reducing the potential for human receptor interaction with MEC at the site. Alternative 3 offers slightly increased long-term effectiveness because potential MEC on the surface and in the subsurface would be removed. However, LUCs, including dig permits for construction support, would still be required in the future along with LTM. Therefore, the benefit of the significant effort associated with Alternative 3 may not justify the cost.

- Reduction of Toxicity, Mobility, or Volume through Treatment: Alternative 1 does not reduce the volume of MEC as there is no action taken. Alternative 2 does not reduce the volume of MEC / MPPEH / munitions debris at the MRSs; however, it is important to note that during the extensive RI fieldwork no MEC (except small arms ammunition not presenting a unique explosive hazard) was found to be present on either MRS. Alternative 3 would potentially reduce the volume of MEC / MPPEH through removal, if any is present. However, there is a residual risk of MEC even following a removal action and, therefore, LUCs and LTM would still be required.

- Short-Term Effectiveness: Alternative 1 does not meet the balancing criteria because no actions would be taken in the short-term to offer protection. Alternative 2 has no short term risk associated with it. Alternative 3 has short term risk to site workers and possibly installation personnel.

- Implementability: Alternative 1 presents no implementation risks. Alternative 2 is the most feasible, as all of the proposed LUCs are easy to implement. Alternative 3 is not considered practicable due to its long implementation time, destruction of the environment, and site worker safety risk for minimal benefit.

- Cost: There are no costs for Alternative 1. Alternative 2 is less costly while still protective of the environment than Alternative 3. Alternative 2 and 3 are both protective of the environment; however, Alternative 3 costs approximately 20 times as much as Alternative 2.

Table 6-1 presents a quantitative analysis of remedial alternatives, scored on a scale of one (least favorable) to three (most favorable). As shown in **Table 6-1,** Alternative 2 has received the highest score. Alternative 2 provides benefits over Alternative 3, as Alternative 2 can be implemented relatively quickly and is less costly than Alternative 3. Alternative 2 and 3 both meet the RAO and RG and would be effective over the short- and long-term, because they control or eliminate the exposure pathway between receptor populations and potential MEC / MPPEH through institutional and engineering controls.

As explained earlier, based on the results of the results of the RI, it was determined that the probability for humans to encounter MEC or MPPEH on both MRSs is low and, therefore, the same remedial alternatives are applicable to both MRSs. The two MRSs were, therefore, evaluated concurrently to avoid redundancy. However, MRS-specific differences in remedies and site controls have been be addressed as part of this FFS and these subtle differences will also be addressed in the Proposed Plan.

7. References

ARCADIS/Malcolm Pirnie. 2011. *Final Former Mortar Range Remedial Investigation Report.* September.

Atkins. 2011. *Real Property Master Plan Update. 90% Submission.* October.

Berger/EA. 2004. *Final Environmental Baseline Survey, Site M, Fort Meade, Maryland*.

Department of Defense Explosives Safety Board. 2004. Technical Paper (TP) 18, Minimum Qualifications for Unexploded Ordnance (UXO) Technicians and Personnel.

Department of the Army. 2001. *Final Environmental Impact Statement Future Development and Operations, Fort George G. Meade, Maryland*.

-----. 2003. Pamphlet 385-63, Range Safety.

Department of the Army, Office of the Assistant Secretary Installation and Environment. 2005. Memorandum for the Assistant Chief of Staff for Installation Management, Subject: Munitions Response Terminology.Fort George G. Meade. 2003. Digital Orthophoto.

-----. Army Regulation 210-20. Master Plan Regulations.

-----. 2003. Geographical Information System (GIS) data.

Mack, Frederick and Achmad Grufron. 1986. *Evaluation of the Water-Supply Potential of Aquifers in the Potomac Group of Anne Arundel County, Maryland*. Maryland Geological Survey Report of Investigations No. 6.

Malcolm Pirnie, Inc. 2001. *Final Soil Background Concentration Report of Fort George G. Meade, Maryland*.

------. 2003. *Final Closed, Transferring, and Transferred Range Inventory, Fort George G. Meade, Maryland*.

------. 2006. *Final Historical Records Review, Fort George G. Meade, Maryland*.

------. 2007. *Final Site Inspection, Fort George G. Meade, Maryland*.

------. 2009a. *Final United States Army Military Munitions Response Program, Munitions Response Remedial Investigation / Feasibility Study Guidance*.

------. 2009b. *Final Work Plan Addendum: Sampling and Analysis Plan, Mortar Range RI, Fort George G. Meade, Maryland*.

Maryland Geological Survey (MGS). 1968. Geologic Map of Maryland.

Microsoft, TerraServer. 2006. USGS Digital Raster Graphic.

R&K Engineering. 2005. *Fort George G. Meade Comprehensive Expansion Master Plan*.

United States Army. 1923. Special Military Map. Maryland: Camp Meade.

------. 2006. *Army Regulation 415-15, Army Military Construction and Nonappropriated-Funded Construction Program Development and Execution.*

United States Army Corps of Engineers (USACE). 2000. Engineer Manual (EM) 1110-1-4009, Ordnance and Explosives Response.

------. 2001a. *Integrated Cultural Resources Management Plan, Fort George G. Meade, Anne Arundel County, Maryland*.

------. 2001b. *Final Soil Background Report, Fort George G. Meade, Maryland*.

------. 2002. *Environmental Baseline Survey United States Army Residential Communities Initiative Properties Fort George G. Meade, Maryland*.

------. 2006. Engineer Pamphlet (EP) 1110-1-18, Military Munitions Response Process.

United States Department of Agriculture. 1972. Soil Survey for Anne Arundel County.

United States Environmental Protection Agency (USEPA). 1988. Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (EPA/540/G-89/004).

------- 1995. Land Use in the CERCLA Remedy Selection Process. Office of Solid Waste and Emergency Response Directive No. 9355.7-04. May.

------. 2000a. A Guide to Developing and Documenting Cost Estimates During the Feasibility Study. Office of Solid Waste and Emergency Response Directive No. 9355.0-75. July.

------. 2000b. Institutional Controls: A Site Manager's Guide to Identifying, Evaluating and Selecting Institutional Controls at Superfund and RCRA Corrective Action Cleanups. Office of Solid Waste and Emergency Response Directive No. 9355.0-74.

------. 2004. ARARs Questions and Answers. Office of Solid Waste and Emergency Response Directive 9234.2-01/FS-4. June.

------. 2006. Guidance for the Data Quality Objectives Process EPA QA/G-4, Final Guidance.

------. 2008. Munitions and Explosives of Concern Hazard Assessment Methodology, Interim. October.

------. 2010. Institutional Controls: A Guide to Planning, Implementing, Maintaining, and Enforcing Institutional Controls at Contaminated Sites. Office of Solid Waste and Emergency Response Directive No. 9355.0-89. November.

United States Geological Survey (USGS). 2002. Laurel 7.5-Minute Quadrangle Map.

United State Census Bureau. 2010. QuickFacts. http://quickfacts.census.gov.

URS Group. 2010. Fort George G. Meade. *Draft Work Plan Preliminary Assessment / Site Inspection Multiple Sites*

------. 2012. *Preliminary Assessment/ Site Investigation Golf Course Areas Of Interest Fort George G. Meade Anne Arundel County, Maryland.* January.

Versar. 2001. *Site Investigation Report of Golf Course Maintenance Area, Buildings 8860, 8880, 8890, and 8896 (SWMUs 131-133 and 135-137), Fort George G. Meade, Maryland*.

------. 2004. *Geophysical Survey of Possible Dump Sites and an Abandoned Cemetery Fort George G. Meade, Maryland*.

TABLES

Table 4-1
Potential Action-Specific ARARs and TBC Guidance
Mortar Range Munitions Response Area, Fort Meade, Maryland

Action	Regulation	Synopsis	Status
Characterization of solid waste	Generation of Solid Waste 40 CFR[1] 262.11(a)-(d)	This regulation provides guidance on the determination of solid waste from hazardous, characteristic, or excluded wastes.	ARAR[2]
	Generation of RCRA[3] Hazardous Waste for Storage, Treatment, and Disposal 40 CFR 264.13(a) (1)	This regulation states that a detailed chemical and physical analysis must be obtained on a representative sample of the waste(s), which at a minimum contains all the information that must be known to treat, store, or dispose of the waste in accordance with pertinent sections of 40 CFR 264 and 268.	ARAR
	Generation of RCRA Hazardous Waste for Storage, Treatment, and Disposal 40 CFR 268.9(a) 40 CFR 268.7(a)	This regulation states that each EPA[4] Hazardous Waste Number (waste code) applicable to the waste must be determined in order to determine the applicable treatment standards under 40 CFR 268.9 (a) and the hazardous constituents in the characteristic waste must be determined. It also must be determined if the hazardous waste meets the treatment standards by testing in accordance with prescribed methods or use of generator knowledge of waste.	ARAR
Hazardous Waste Management	Permitting for RCRA Hazardous Waste Miscellaneous Units RCRA Subpart X	The standards are applicable to owners and operators of new and existing hazardous waste management units not covered under the existing regulations. This will enable EPA, and the States that adopt equivalent authorities, to issue permits to miscellaneous waste management units.	ARAR
Disposal and Transport of MEC[5]/MPPEH[6]	Safety and Health Requirements Manual EM[7] 385-1-97	This guidance document prescribes the safety and health requirements for all USACE[8] activities and operations that involve explosives related work.	TBC[9]
	Military Munitions Response Actions EM 1110-1-4009	This guidance document provides the USACE personnel with the procedures to be used to perform engineering and design activities for all phases of the Military Munitions Response Program (MMRP).	TBC

Table 4-1
Potential Action-Specific ARARs and TBC Guidance
Mortar Range Munitions Response Area, Fort Meade, Maryland

Action	Regulation	Synopsis	Status
Erosion and Sediment Control	Erosion and Sediment Control *COMAR*[10] *26.17.01*	This regulation is applicable when excavation or on-site storage of contaminated soil and waste is contemplated. It sets criteria and procedures to protect the lands and waters comprising the watersheds of the state and prohibits discharge of raw sewage or waste into the Patuxent or Severn rivers or their watersheds. The limits for phosphorus and nitrogen in wastewater effluent are set at 0.3 mg/L and 3.0 mg/L, respectively.	ARAR
Excavation and Off-site Disposal	Disposal of Controlled Hazardous Substances COMAR 26.13	This regulation provides for the prevention, abatement, and control of contamination by addressing the generation and disposal of hazardous substances, and it authorizes the regulation of storage, treatment, transportation, and disposal of hazardous materials, controlled hazardous substances, and low level nuclear waste.	ARAR
MEC/MPPEH Disposal	Explosive Ordnance Disposal TM[11] 60A-1-1-31	This guidance document specifies how Ordnance and Explosives operations should be performed on project sites.	TBC
MEC/MPPEH Handling	Ammunition and Explosives Safety *DoD*[12] *6055.09-STD*[13]	This guidance establishes uniform safety standards applicable to ammunition and explosives throughout their life-cycle, to protect associated personnel and property, unrelated personnel and property, and the environment from the potential damaging effects of an accident involving ammunition and explosives.	TBC
Temporary storage of hazardous waste in containers	Accumulation of RCRA hazardous waste on site 40 *CFR* 262.34	This regulation provides for the temporary storage systems in accordance with 40 *CFR* 262.34.	ARAR
Transportation of hazardous materials	Transportation of hazardous materials 49 *CFR* 171.1(c)	This regulation states that waste shall be subject to and must comply with all applicable provisions of the Hazardous Materials Transportation Act and Hazardous Materials Regulations at 49 CFR 171-180 related to marking, labeling, placarding, packaging, emergency response, etc.	ARAR

Table 4-1
Potential Action-Specific ARARs and TBC Guidance
Mortar Range Munitions Response Area, Fort Meade, Maryland

Action	Regulation	Synopsis	Status
	Preparation and initiation of shipment of hazardous waste off-site 40 *CFR* 262.10(h)	This regulation states that waste must be in compliance with the generator requirements of 40 CFR 262.20–23and 262.20-262.27 for manifesting, Sect. 262.30 for packaging, Sect. 262.31 for labeling, Sect. 262.32 for marking, Sect. 262.33 for placarding and Sect. 262.40, 262.41(a) for record keeping requirements and Sect. 262.12 to obtain EPA ID number.	ARAR

Notes:
[1]CFR=Code of Federal Regulations
[2]ARAR= Applicable or Relevant and Appropriate Requirement
[3]RCRA=Resource Conservation and Recovery Act
[4]EPA=Environmental Protection Agency
[5]MEC=Munitions and Explosives of Concern
[6]MPPEH= Material Potentially Presenting An Explosive Hazard
[7]EM=Engineering Manual
[8]USACE=United States Army Corps of Engineers
[9]TBC= To-Be-Considered
[10]COMAR=Code of Maryland Regulations
[11]TM=Technical Manual
[12]DoD=Department of Defense
[13]STD=Standard

Table 6-1
Quantitative Analysis of Remedial Alternatives
Mortar Range MRA, Fort George G. Meade, Maryland

Evaluation Criteria		Alternative 1: No Action	Alternative 2: LUCs and LTM	Alternative 3: 100% Surface and Subsurface Removal with LUCs And LTM
Threshold Criteria				
1	Overall protection of Human Health and the Environment	Does Not Satisfy Criteria	Satisfies Criteria	Satisfies Criteria
2	Compliance with ARARs	Does Not Satisfy Criteria	Satisfies Criteria	Satisfies Criteria
Balancing Criteria				
3	Long-term effectiveness and permanence	Does Not Satisfy Criteria	Satisfies Criteria	Satisfies Criteria
4	Reduction of volume, or removal of, MEC	Does Not Satisfy Criteria	Does Not Satisfy Criteria	Partially Satisfies Criteria
5	Short-term effectiveness	Does Not Satisfy Criteria	Satisfies Criteria	Partially Satisfies Criteria
6	Implementability	Satisfies Criteria	Satisfies Criteria	Partially Satisfies Criteria
7	Cost	Satisfies Criteria	Satisfies Criteria	Partially Satisfies Criteria
Modifying Criteria				
8	State Acceptance	Not Scored	Not Scored	Not Scored
9	Community Acceptance	Not Scored	Not Scored	Not Scored
Overall Criteria Score		Does Not Satisfy Criteria	Satisfies Criteria	Partially Satisfies Criteria

Notes:
Not Scored items will be scored as part of the Proposed Plan.

ARARs—Applicable or relevant and Appropriate Requirements
LTM—Long Term Monitoring
LUCs—Land Use Controls

Table 6-2

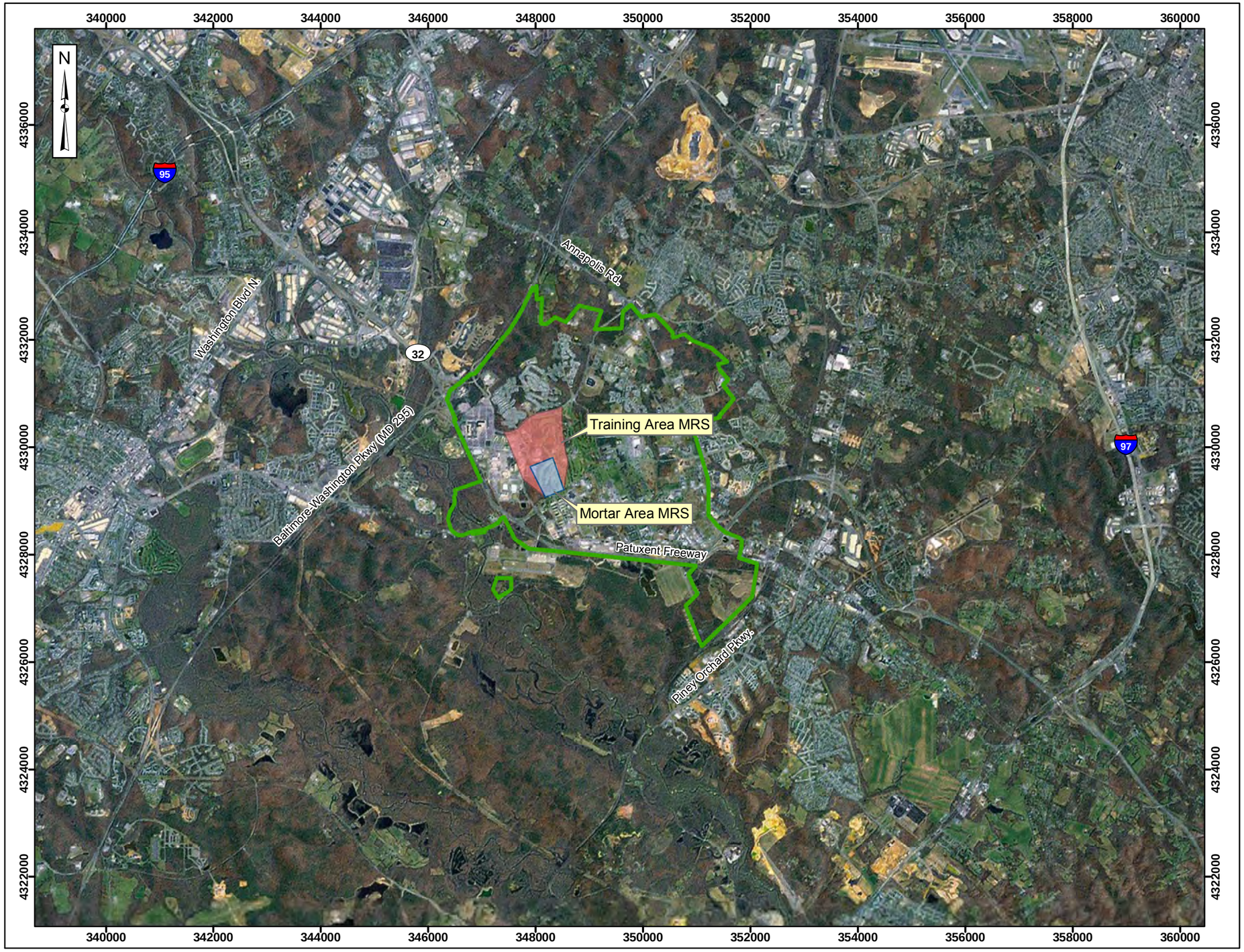
Remedial Alternatives Cost Summary

Mortar Range MRA, Fort George G. Meade, Maryland

Alternative Number	Description	Capital Cost	O&M Cost	Present Worth Costs	Total Cost
1	No Action	$0	$0	$0	$0
2	LUCs with LTM	$215,100	$365,700	$124,700	$340,000
3	Surface and Subsurface Removal with LUCs and LTM	$6,785,950	$365,700	$124,700	$6,911,000

Note: Cost assumptions are listed in Appendix A.

FIGURES



Fort George G. Meade
Focused Feasibility Study

ARCADIS

Figure 2-1
Site Location

Legend

- Installation Boundary
- Mortar Range MRA
  - Mortar Area MRS
  - Training Area MRS

0 1,000 2,000 3,000
Meters

Data Sources: ESRI, ArcGIS Online, Aerial Photo, 2002
FGGM, GIS Data, 2005

Coordinate System: UTM Zone 18
Datum: NAD 1983
Units: Meters

Date: June 2012

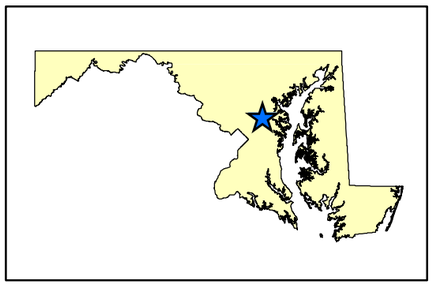
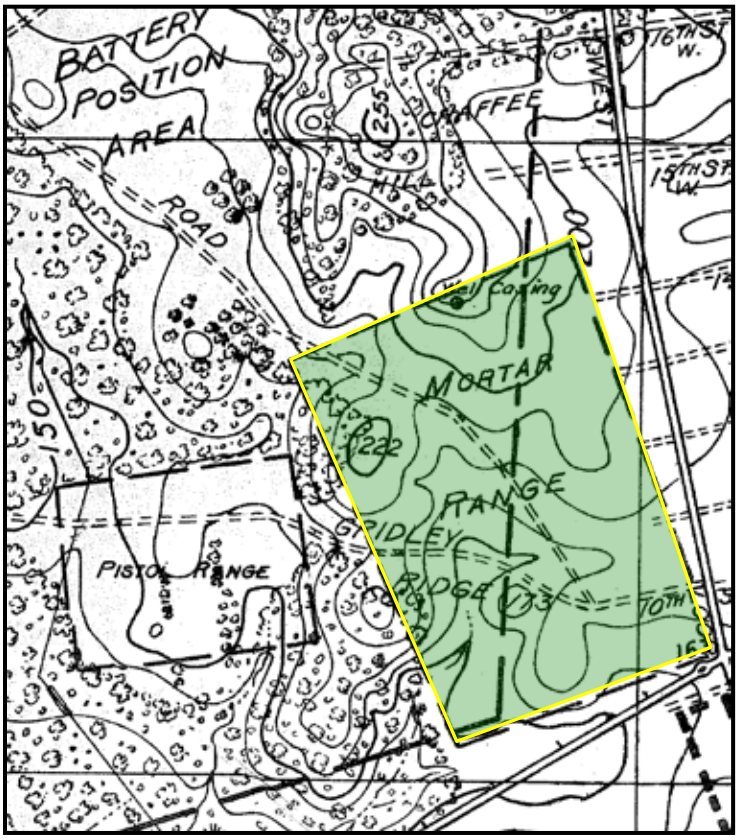


Figure 2-2
1923 Special Military Map with Mortar Range
Fort George G. Meade, Maryland



Source: U.S. Army. 1923. Special Military Map. Maryland: Camp Meade.

Fort George G. Meade
Focused Feasibility Study

ARCADIS

Figure 2-3
Hydrology

Legend

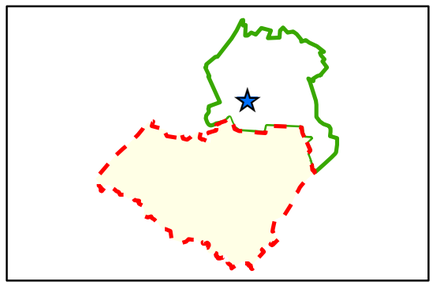
- Installation Boundary
- Mortar Range MRA
- Training Area MRS
- Mortar Area MRS
- Stream

0 100 200 300 400 Meters

Data Sources: FGGM, Digital Orthophoto, 2003
FGGM, GIS Data, 2005
CTT Inventory Data, 2005

Coordinate System: UTM Zone 18
Datum: NAD 1983
Units: Meters

Contract: W912DR-05-D-0004
Date: June 2012



Fort George G. Meade
Focused Feasibility Study

ARCADIS

Figure 3-1
Munitions Debris Locations

Legend

- Installation Boundary
- Mortar Range MRA
- Training Area MRS
- Mortar Area MRS

Munitions Debris Items Found*

- 81 mm Training Mortar Round
- 60 mm Training Mortar Round
- 3-inch Stokes Training Mortar Range
- Expended 60 mm Illumination Mortar
- Dummy Grenade
- Practice Grenade
- Practice Landmine
- Expended Flare Trip M48
- Expended Flare
- Small Arms Ammunition Box
- Small Arms Ammunition Casing Disposal Pit**

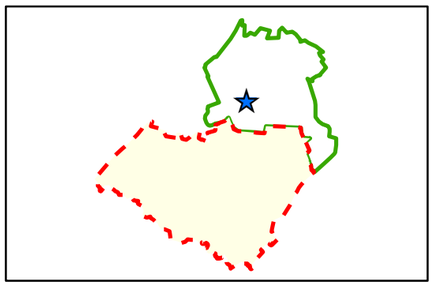
*Symbol may represent multiple munitions debris.
**Left in place

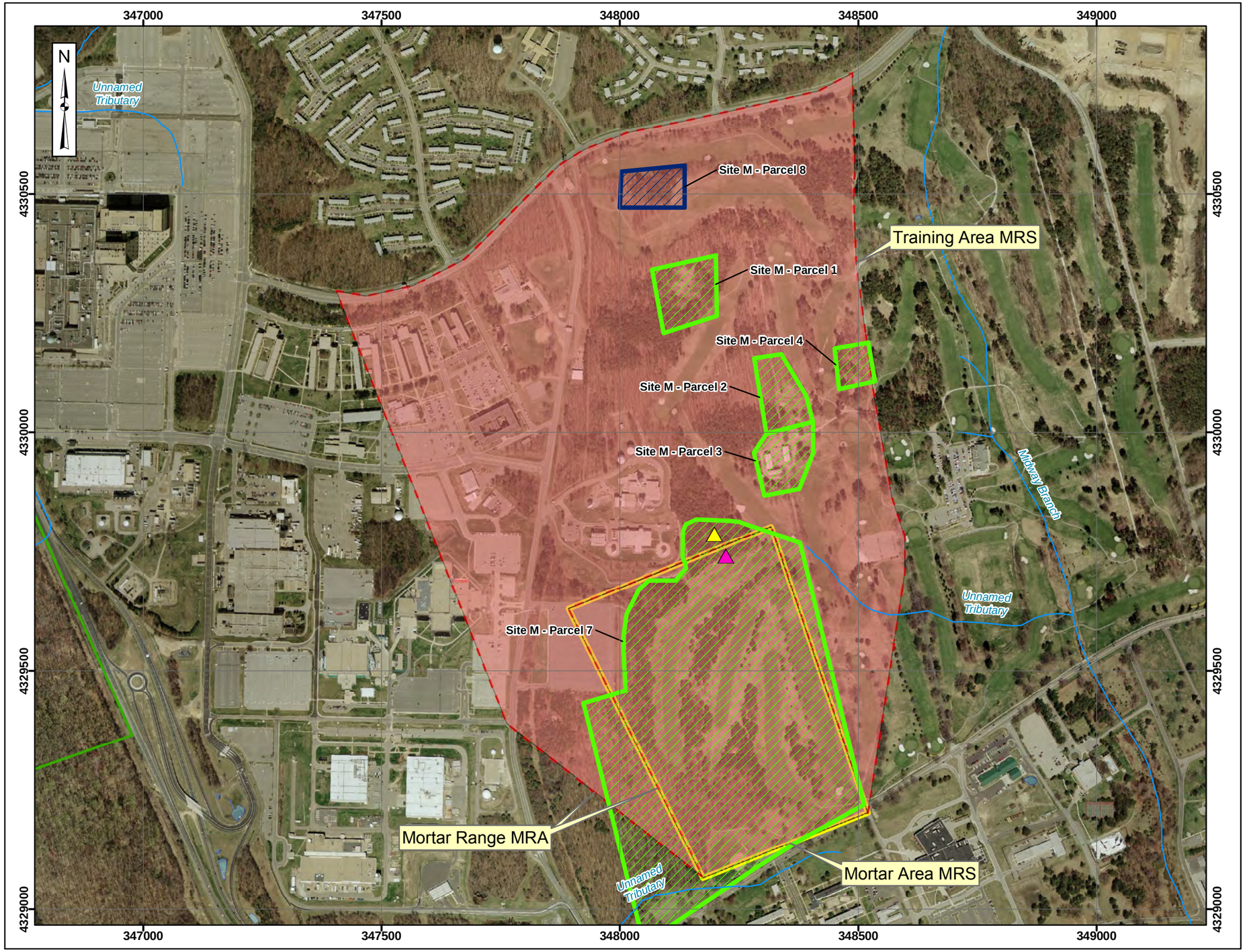
0 100 200 300 400 Meters

Data Sources: FGGM, Digital Orthophoto, 2003
FGGM, GIS Data, 2005
CTT Inventory Data, 2005

Coordinate System: UTM Zone 18
Datum: NAD 1983
Units: Meters

Contract: W912DR-05-D-0004
Date: February 2012





Fort George G. Meade
Focused Feasibility Study

ARCADIS

Figure 3-2
PA/SI Site Boundaries and Munitions-Related Findings

Legend

- Installation Boundary
- Mortar Range MRA
- Training Area MRS
- Mortar Area MRS
- PA/SI Site Boundary (Further Action)
- PA/SI Site Boundary (No Further Action)
- Stream

EOD Finds

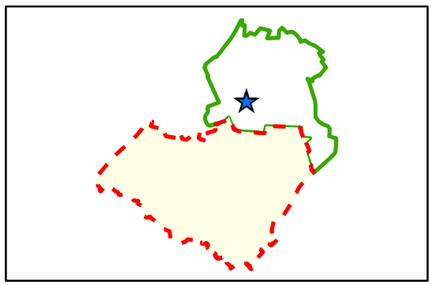
- Mk1 Shrapnel Projectile
- 3in Trench Mortar (Stokes) Training (no fuze)

0 100 200 300 400 Meters

Data Sources: FGGM, Digital Orthophoto, 2003
FGGM, GIS Data, 2005
CTT Inventory Data, 2005

Coordinate System: UTM Zone 18
Datum: NAD 1983
Units: Meters

Contract: W912DR-05-D-0004
Date: June 2012



Appendix A

Detailed Remedial Cost Analyses

Table A-1
Alternative 2-Cost Estimate
Land Use Controls and LTM
Mortar Range MRA, Fort Meade, Maryland

ITEM		QUANTITY	UNITS[1]	UNIT COST[2]	CAPITAL COST	ANNUAL O&M COST	PRESENT WORTH COST[1-3]	ASSUMPTIONS[4]
I. ADMINISTRATIVE ACTIONS								
1. Land-Use Restrictions	*Labor & Materials*	1	LS	$5,000	$5,000	$0	---	Engineering estimate for materials (signs [$3000]) and labor (20 hrs x $100/hr) to implement LUCs to manage any intrusive activity that may occur at the MRA
2. Planning								
a. Remedial Design	*Labor*	30	Hour	$150	$4,500	$0	---	Engineering estimate for labor to draft, submit, and finalize the remedial design
b. Remedial Action Work Plan (*i.e.,* Land Use Control Plan)	*Labor*	550	Hour	$150	$82,500	$0	---	Engineering estimate for labor to draft, submit, and finalize the remedial action work plan (*i.e.* , land use control plan)
3. Installation Coordination and Educational Program	*Labor*	200	Hour	$150	$30,000	$0	---	Engineering Estimate for labor to coordinate with installation personnel during removal activities and develop educational programs for on-site workers
SUBTOTAL					$122,000	$0	$0	
II. GENERAL ACTIONS AND SITE PREPARATION								
1. MPPEH/MD Handling	*Labor & Materials*	1	LS	$3,500	$3,500	$0	---	Engineering estimate to dispose 200 lbs of small arms ammunition casings that were discarded at the MRA in a burial pit; costs include labor and materials
SUBTOTAL					$3,500	$0	$0	
SUBTOTAL (I and II)					$125,500	$0	$0	
III. LONG-TERM MANAGEMENT, MONITORING & REVIEW								
1. Surface Sweep and Site Maintenance	*Labor & Materials*	30	Years	$7,600	$0	$228,000	$94,300	Engineering estimate to conduct surface sweep by 2 UXO/field technicians (2 technicians x 40 hrs x $75/hr), report (12 hrs x $100/hr), and maintain/replace ($400) signage
2. Five-Year Review Reports	*Labor*	6	LS	$15,000	$0	$90,000	$10,700	Engineering estimate to compile the Draft, Draft Final, and Final versions of the Five-Year Review Report for the Mortar Range MRA
SUBTOTAL					$0	$318,000	$105,000	
SUBTOTAL (I, II and III)					$125,500	$318,000	$105,000	
IV. IMPLEMENTATION COSTS								
1. Administration and Legal	5% of Capital Costs	1	LS	$6,300	$6,300	$0	---	
2. Procurement	5% of Capital Costs	1	LS	$6,300	$6,300	$0	---	
3. Project Management	12% of Capital Costs	1	LS	$15,100	$15,100	$0	---	
4. Remedial Action Completion Report	*Labor*	120	Hour	$150	$18,000	$0	---	Engineering estimate to compile the Draft, Draft Final, and Final versions of the Remedial Action Completion Report for the Mortar Range MRA
5. Cost Contingency	35% of Capital Costs	1	LS	$43,900	$43,900	$0	---	
6. O&M Contingency	15% of O&M Costs	1	LS	$47,700	$0	$47,700	$19,700	
SUBTOTAL					$89,600	$47,700	$19,700	
SUBTOTAL (I, II, III, and IV)					$215,100	$365,700	$124,700	
A. TOTAL CAPITAL COSTS					$215,100			
B. TOTAL ANNUAL COSTS						$365,700		
C. TOTAL PRESENT WORTH OF ANNUAL COSTS							$124,700	
TOTAL PRESENT WORTH OF CAPITAL AND ANNUAL COSTS (A + C)							**$340,000**	

LS - Lump Sum
(1) Labor categories for reporting tasks includes project engineer. Project manager costs are captured under IV.3. - Project/Construction Management as a 12% of the total capital costs. Labor categories for O&M includes 2 UXO/field technicians.
(2) All unit costs are an engineering estimate
(3) Present worth costs are calculated using 7% interest and year 2011 dollars
(4) All numbers are rounded to the nearest thousand
All construction assumed to be conducted in Level D PPE

Table A-2
Alternative 3-Cost Estimate
100% Surface and Subsurface Removal, with LUCs, and LTM
Mortar Range MRA, Fort Meade, Maryland

ITEM		QUANTITY	UNITS(1)	UNIT COST(2)	CAPITAL COST	ANNUAL O&M COST	PRESENT WORTH COST(3)	ASSUMPTIONS(4)
I. ADMINISTRATIVE ACTIONS								
1. Land-Use Restrictions	*Labor & Materials*	1	LS	$5,000	$5,000	$0	---	Engineering estimate for materials (signs [$3000]) and labor (20 hrs x $100/hr) to implement LUCs to manage any intrusive activity that may occur at the MRA
2. Planning								
a. Remedial Design	*Labor*	30	Hour	$150	$4,500	$0	---	Engineering estimate for labor to draft, submit, and finalize the remedial design
b. Remedial Action Work Plan and sub-plans	*Labor*	550	Hour	$150	$82,500	$0	---	Engineering estimate for labor to draft, submit, and finalize the remedial action work plan and sub-plans (*e.g.* , Sediment Erosion Control, Site Restoration, Site Management, Accident Prevention Plan/Site Safety and Health Plan)
c. Explosive Safety Submittal	*Labor*	225	Hour	$150	$33,750	$0	---	Engineering estimate for labor to draft, submit, and finalize explosive safety submittal
d. Land Use Control Plan	*Labor*	100	Hour	$150	$15,000	$0	---	Engineering estimate for labor to draft, submit, and finalize the Land Use Control Plan
3. Installation Coordination and Educational Program	*Labor*	200	Hour	$150	$30,000	$0	---	Engineering Estimate for labor to coordinate with installation personnel during removal activities and develop educational programs for on-site workers
SUBTOTAL					$170,750	$0	$0	
II. GENERAL ACTIONS AND SITE PREPARATION								
1. Mobilization / Demobilization	*Labor & Materials*	1	LS	$35,000	$35,000	$0	---	Engineering estimate to mobilize equipment and personnel to and from the site
2. Land Surveying	*Labor & Materials*	1	LS	$151,100	$151,100	$0	---	Engineering estimate to conduct survey activities on 250 acres for investigation, clearance, and construction layout using a subcontractor along with a UXO escort while within the range boundary. The 250 acres corresponds to the: 118 acres wooded area + 113 a
3. Surface Sweep	*Labor & Materials*	118	per acre	$2,309	$272,500	$0	---	Engineering estimate for UXO technicians to conduct surface sweep on 118 acres of the wooded area of the MRA
4. Brush Cutting	*Labor & Materials*	118	per acre	$1,309	$154,500	$0	---	Engineering estimate for vegetation removal on 118 acres, assuming light and moderate vegetation removal will be required
5. Mag and Dig	*Labor & Materials*	19	per acre	$16,384	$311,301	$0	---	Engineering estimate to perform mag and dig on 19 acres, consisting of small patches of grass between buildings in the northwestern portion of the site
6. DGM Surveying	*Labor & Materials*	231	per acre	$595	$137,350	$0	---	Engineering estimate to perform DGM survey on 231 acres (consisting of 118-acres of the wooded area plus 113-acres of the golf greenspace) , assuming a production rate of 2.5 acres/day for a 100' x 100' grid
7. Anomaly Reacquisition and Marking	*Labor & Materials*	1	LS	$1,094,000	$1,094,000	$0	---	Engineering estimate for anomaly target lists that will be developed for each DGM grid, assuming a production rate of 150 anomalies/day/team
8. Intrusive Anomaly Investigation	*Labor & Materials*	1	LS	$1,820,000	$1,820,000	$0	---	Engineering estimate to investigate for anomalies, assuming all anomalies will be hand-dug by qualified UXO technicians at a production rate of 150 anomalies/day/team
9. Demolition	*Labor & Materials*	10	per shot	$8,000	$80,000	$0	---	Engineering estimate for explosive demolition of MEC items using consolidated and BIP procedures (assuming 10 shots), and cost includes delivery and storage of demolition materials
10. MPPEH/MD Handling	*Labor & Materials*	10	per ton	$4,250	$42,500	$0	---	Engineering estimate for 10 tons of scraps recovered during clearance activities to be transferred to a centralized secure storage area for inpsection, demolition, and certification as well as disposal of 200 lbs of small arms ammunition casings that were discarded at the MRA in a burial pit
11. GIS	*Labor*	1	LS	$27,000	$27,000	$0	---	Engineering estimate for GIS staff (300 hrs x $90/hr) to incorporate previously and newly collected and generated spatial data of the site
SUBTOTAL					$4,125,250	$0	$0	
SUBTOTAL (I and II)					$4,296,000	$0	$0	
III. LONG-TERM MANAGEMENT, MONITORING & REVIEW								
1. Surface Sweep and Site Maintenance	*Labor & Materials*	30	Years	$7,600	$0	$228,000	$94,300	Engineering estimate to conduct surface sweep by 2 UXO technicians (2 technicians x 40 hrs x $75/hr), report (12 hrs x $100/hr), and maintain/replace ($400) signage
2. Five-Year Review Reports	*Labor*	6	LS	$15,000	$0	$90,000	$10,700	Engineering estimate to compile the Draft, Draft Final, and Final versions of the Five-Year Review Report for the Mortar Range MRA
SUBTOTAL					$0	$318,000	$105,000	
SUBTOTAL (I, II and III)					$4,296,000	$318,000	$105,000	
IV. IMPLEMENTATION COSTS								
1. Administration and Legal	5% of Capital Costs	1	LS	$214,800	$214,800	$0	---	
2. Procurement	5% of Capital Costs	1	LS	$214,800	$214,800	$0	---	
3. Project/Construction Management	12% of Capital Costs	1	LS	$515,500	$515,500	$0	---	
4. Remedial Action Completion Report	*Labor*	275	Hour	$150	$41,250	$0	---	Engineering estimate to compile the Draft, Draft Final, and Final versions of the Remedial Action Completion Report for the Mortar Range MRA
5. Cost Contingency	35% of Capital Costs	1	LS	$1,503,600	$1,503,600	$0	---	
6. O&M Contingency	15% of O&M Costs	1	LS	$47,700	$0	$47,700	$19,700	
SUBTOTAL					$2,489,950	$47,700	$19,700	
SUBTOTAL (I, II, III, and IV)					$6,785,950	$365,700	$124,700	
A. TOTAL CAPITAL COSTS					$6,785,950			
B. TOTAL ANNUAL COSTS						$365,700		
C. TOTAL PRESENT WORTH OF ANNUAL COSTS							$124,700	
TOTAL PRESENT WORTH OF CAPITAL AND ANNUAL COSTS (A + C)							**$6,911,000**	

LS - Lump Sum
(1) Labor categories for reporting tasks includes project engineer. Project manager costs are captured under IV.3. - Project/Construction Management as a 12% of the total capital costs. Labor categories for O&M includes 2 UXO/field technicians.
(2) All unit costs are an engineering estimate
(3) Present worth costs are calculated using 7% interest and year 2011 dollars
(4) All numbers are rounded to the nearest thousand
All construction assumed to be conducted in Level D PPE

Appendix B

Response to Comments

Response to Comments Table

Draft Focused Feasibility Study, Mortar Range, Fort George G. Meade, MD

March 2012

Response Code: A = Agree with comment D = Disagree with comment C = Comment requires clarification N = Comment noted, no action required or taken

Comment Number	Commenter	Page(s)	Section	Line(s)	Comment	Response Code	Response
1	MDE		General		The description of the Long term Monitoring that is included as part of Alternatives 2 and 3 mentions that annual surface inspections will be completed. Will these be visual inspections only, or instrument assisted?	A	These inspections will consist of an instrument-assisted surface sweep. This has been clarified in the text to "...to confirm that the land use of the site has not changed, and to confirm through instrument-assisted surface sweep that no MEC / MPPEH/ munitions debris has been exposed through erosion or frost heave."
2	MDE		General		The Land use Controls implemented as part of the preferred remedy should prevent use of the Munitions Response Area for residential use. The Installation Master Plan should be modified to reflect this.	A	Residential land use will be prohibited as part of the LUCs. This will be added to the text and the Installation Master Plan will be modified. The following text has been added to section 5.2 "No future residential development is planned within the MRA boundary. Residential land use at the former Mortar Range MRA will be prohibited as part of LUCs. This will be updated in the Master Plan."
1	EPA/RPM	Page 5-2			Please note that an LUC RD and Remedial Action Completion Report will have to be completed for this site following the RoD. I have good examples if you would like one to be provided.	A/N	These examples would be appreciated.
2	EPA/RPM			Table 6-1	Please change the table to the “satisfies criteria/partially satisfies criteria/Does not satisfy criteria” type instead of trying to numerically quantify the criteria for each alternative.	A	Numbering system will be revised to the criteria proposed in this comment.
1	EPA/Tox	Page ES-1, 2nd bullet; page 1-2, 1st paragraph; page 3-5, 2nd bullet; page 3-5, last paragraph to page 3-6, 1st paragraph; Section 3.3, 2nd paragraph; Section			The situation is not that COPCs were not identified or do not pose a risk, but that EPA was told these chemicals will be addressed under separate cover (PA/SIs for Site M).	A	Comment noted, the non-munitions related COPCs will be addressed under a separate cover (PA/SIs for Site M). This decision was agreed upon and finalized in the RI for the Mortar Range MRA. To avoid confusion and unnecessary complication moving forward, all future phases of this investigation will incorporate these agreed upon decisions and will continue to be focused issues relevant to the Military Munitions Response Program (i.e., MEC).
2	EPA/Tox				Much is made of the access restrictions; however, page 3-1 states that the golf course (where the bulk of this site lies) is not fenced.	A	Currently only a portion of the Training Area MRS is fenced. Development of a majority of the MRA is planned and is underway. This development is an expansion of the secure DoD facility and includes restricted access in the form of fencing and guards. The paragraph has been revised to: "FGGM is a fenced, closed installation. Guards and surveillance at all entrances restrict access. Once inside the installation, numerous buildings and areas have restricted access and are guarded. The portion of the site that is DoD property is fenced and has additional security. The current construction on the majority of the MRA (the former golf course) is an expansion of the existing secure DoD facility. This facility will be fenced after the completion of construction."
3	EPA/Tox		Section 4.3.3	Table 4-1	The Army will, and should, bear most of the responsibility for identifying the proper handling of MEC and MPPEH. They should ensure that all appropriate ARARs and TBCs have been identified, including DDESB standards, DOD regulations and policies for MEC and MPPEH, etc.	A	The Army will bear the responsibility for identifying the proper handling of MEC/MPPEH. The Army will comply with all regulations with regard to avoidance, disposal, and transport of MEC/MPPEH. DDESB 6055.09-M will be added to Table 4-1 as a TBC for MEC/MPPEH Handling.
4	EPA/Tox		Section 4.4		The RAO specifies limiting “direct physical contact with possible MEC/MPPEH.” However, direct physical contact is not always needed to trigger or sustain injury from explosive materials.	A	Bullet has been revised to "Control and minimize the potential for contact of receptors with possible MEC at the surface and within the subsurface."
5	EPA/Tox				Site users and workers include golfers, golf course maintenance workers, and construction workers. All efforts to control the access of, and educate, site users and workers should include these subgroups.	A	As the majority of the MRA is now a construction site and the golf course (and jogging trail) have been permanently closed, these subgroups have been revised to "construction workers, potential future site workers, and emergency responders of the MRA." These workers will be targeted during education programs and access restrictions.

Response to Comments Table

Draft Focused Feasibility Study, Mortar Range, Fort George G. Meade, MD

March 2012

Response Code: A = Agree with comment D = Disagree with comment C = Comment requires clarification N = Comment noted, no action required or taken

Comment Number	Commenter	Page(s)	Section	Line(s)	Comment	Response Code	Response
6	EPA/Tox			Table 6-1	For Alternative 2, some of the scores are arguable. For example, the long-term effectiveness should be less than that of Alternative 3 (and therefore probably a 2); the cost is more than that of Alternative 1 (and therefore probably a 2).	A	The numbering system will be revised into a "satisfies criteria/partially satisfies criteria/does not satisfy criteria" system. This comment will be taken into account in the change.
1	EPA/BTAG				In the Executive Summary, Section 3.1.5 Remedial Investigation (page 3-5), and Section 3.3 Summary of the Risk Assessments it is stated that no Contaminants of Potential Ecological Concern were identified in the SLERA. BTAG understands that the full suite of analytes was not considered in the SLERA, but the focus was on MC and metals associated with munitions, and of those contaminants considered, no COPECs were identified. If this is the case this information should be included in the three sections mentioned.	A	The text was revised to "The Screening Level Ecological Risk Assessment (SLERA) concluded that adverse health effects in ecological receptors from exposure to MC in surface soil are not likely at either of the MRSs, and no Contaminants of Potential Ecological Concern associated with MC metals were identified."
2	EPA/BTAG				The following is possible language that could be adopted – "and no Contaminants of Potential Ecological Concern associated with MC metals were identified."	A	The text was revised to "The Screening Level Ecological Risk Assessment (SLERA) concluded that adverse health effects in ecological receptors from exposure to MC in surface soil are not likely at either of the MRSs, and no Contaminants of Potential Ecological Concern associated with MC metals were identified."
3	EPA/BTAG				The BTAG supports the overall conclusions and recommendation for selection of Alternative 2 with one caveat. On the top of Page 5-4, the document states that the spent casings will be removed from the disposal pit at the Training Area as a preliminary maintenance activity. Casings usually consist of brass which is 70% copper and 30% zinc. The BTAG requests that as part of the removal, the Army conduct chemical analyses of soil samples from the newly exposed areas under and in the perimeter of the pit to determine the concentration of chemicals of potential concern. This should consist of an analysis of the full suite of Target Analyte List metals to ensure that the area does not pose a risk to ecological receptors or ground water.	N	Comment noted. This will be taken under consideration during the Remedial Design phase.

Response to Comments Table

Draft Focused Feasibility Study, Mortar Range, Fort George G. Meade, MD

March 2012

Response Code: A = Agree with comment D = Disagree with comment C = Comment requires clarification N = Comment noted, no action required or taken

Comment Number	Commenter	Page(s)	Section	Line(s)	Comment	Response Code	Response
1	MDE		General		The description of the Long term Monitoring that is included as part of Alternatives 2 and 3 mentions that annual surface inspections will be completed. Will these be visual inspections only, or instrument assisted?	A	These inspections will consist of an instrument-assisted surface sweep. This has been clarified in the text to "...to confirm that the land use of the site has not changed, and to confirm through instrument-assisted surface sweep that no MEC / MPPEH/ munitions debris has been exposed through erosion or frost heave."
2	MDE		General		The Land use Controls implemented as part of the preferred remedy should prevent use of the Munitions Response Area for residential use. The Installation Master Plan should be modified to reflect this.	A	Residential land use will be prohibited as part of the LUCs. This will be added to the text and the Installation Master Plan will be modified. The following text has been added to section 5.2 "No future residential development is planned within the MRA boundary. Residential land use at the former Mortar Range MRA will be prohibited as part of LUCs. This will be updated in the Master Plan."
1	EPA/RPM	Page 5-2			Please note that an LUC RD and Remedial Action Completion Report will have to be completed for this site following the RoD. I have good examples if you would like one to be provided.	A/N	These examples would be appreciated.
2	EPA/RPM			Table 6-1	Please change the table to the “satisfies criteria/partially satisfies criteria/Does not satisfy criteria” type instead of trying to numerically quantify the criteria for each alternative.	A	Numbering system will be revised to the criteria proposed in this comment.
1	EPA/Tox	Page ES-1, 2nd bullet; page 1-2, 1st paragraph; page 3-5, 2nd bullet; page 3-5, last paragraph to page 3-6, 1st paragraph; Section 3.3, 2nd paragraph; Section			The situation is not that COPCs were not identified or do not pose a risk, but that EPA was told these chemicals will be addressed under separate cover (PA/SIs for Site M).	A	Comment noted, the non-munitions related COPCs will be addressed under a separate cover (PA/SIs for Site M). This decision was agreed upon and finalized in the RI for the Mortar Range MRA. To avoid confusion and unnecessary complication moving forward, all future phases of this investigation will incorporate these agreed upon decisions and will continue to be focused issues relevant to the Military Munitions Response Program (i.e., MEC).
2	EPA/Tox				Much is made of the access restrictions; however, page 3-1 states that the golf course (where the bulk of this site lies) is not fenced.	A	Currently only a portion of the Training Area MRS is fenced. Development of a majority of the MRA is planned and is underway. This development is an expansion of the secure DoD facility and includes restricted access in the form of fencing and guards. The paragraph has been revised to: "FGGM is a fenced, closed installation. Guards and surveillance at all entrances restrict access. Once inside the installation, numerous buildings and areas have restricted access and are guarded. The portion of the site that is DoD property is fenced and has additional security. The current construction on the majority of the MRA (the former golf course) is an expansion of the existing secure DoD facility. This facility will be fenced after the completion of construction."
3	EPA/Tox		Section 4.3.3	Table 4-1	The Army will, and should, bear most of the responsibility for identifying the proper handling of MEC and MPPEH. They should ensure that all appropriate ARARs and TBCs have been identified, including DDESB standards, DOD regulations and policies for MEC and MPPEH, etc.	A	The Army will bear the responsibility for identifying the proper handling of MEC/MPPEH. The Army will comply with all regulations with regard to avoidance, disposal, and transport of MEC/MPPEH. DDESB 6055.09-M will be added to Table 4-1 as a TBC for MEC/MPPEH Handling.
4	EPA/Tox		Section 4.4		The RAO specifies limiting “direct physical contact with possible MEC/MPPEH.” However, direct physical contact is not always needed to trigger or sustain injury from explosive materials.	A	Bullet has been revised to "Control and minimize the potential for contact of receptors with possible MEC at the surface and within the subsurface."
5	EPA/Tox				Site users and workers include golfers, golf course maintenance workers, and construction workers. All efforts to control the access of, and educate, site users and workers should include these subgroups.	A	As the majority of the MRA is now a construction site and the golf course (and jogging trail) have been permanently closed, these subgroups have been revised to "construction workers, potential future site workers, and emergency responders of the MRA." These workers will be targeted during education programs and access restrictions.

Response to Comments Table

Draft Focused Feasibility Study, Mortar Range, Fort George G. Meade, MD

March 2012

Response Code: A = Agree with comment D = Disagree with comment C = Comment requires clarification N = Comment noted, no action required or taken

Comment Number	Commenter	Page(s)	Section	Line(s)	Comment	Response Code	Response
6	EPA/Tox			Table 6-1	For Alternative 2, some of the scores are arguable. For example, the long-term effectiveness should be less than that of Alternative 3 (and therefore probably a 2); the cost is more than that of Alternative 1 (and therefore probably a 2).	A	The numbering system will be revised into a "satisfies criteria/partially satisfies criteria/does not satisfy criteria" system. This comment will be taken into account in the change.
1	EPA/BTAG				In the Executive Summary, Section 3.1.5 Remedial Investigation (page 3-5), and Section 3.3 Summary of the Risk Assessments it is stated that no Contaminants of Potential Ecological Concern were identified in the SLERA. BTAG understands that the full suite of analytes was not considered in the SLERA, but the focus was on MC and metals associated with munitions, and of those contaminants considered, no COPECs were identified. If this is the case this information should be included in the three sections mentioned.	A	The text was revised to "The Screening Level Ecological Risk Assessment (SLERA) concluded that adverse health effects in ecological receptors from exposure to MC in surface soil are not likely at either of the MRSs, and no Contaminants of Potential Ecological Concern associated with MC metals were identified."
2	EPA/BTAG				The following is possible language that could be adopted – "and no Contaminants of Potential Ecological Concern associated with MC metals were identified."	A	The text was revised to "The Screening Level Ecological Risk Assessment (SLERA) concluded that adverse health effects in ecological receptors from exposure to MC in surface soil are not likely at either of the MRSs, and no Contaminants of Potential Ecological Concern associated with MC metals were identified."
3	EPA/BTAG				The BTAG supports the overall conclusions and recommendation for selection of Alternative 2 with one caveat. On the top of Page 5-4, the document states that the spent casings will be removed from the disposal pit at the Training Area as a preliminary maintenance activity. Casings usually consist of brass which is 70% copper and 30% zinc. The BTAG requests that as part of the removal, the Army conduct chemical analyses of soil samples from the newly exposed areas under and in the perimeter of the pit to determine the concentration of chemicals of potential concern. This should consist of an analysis of the full suite of Target Analyte List metals to ensure that the area does not pose a risk to ecological receptors or ground water.	N	Comment noted. This will be taken under consideration during the Remedial Design phase.