Corrective Measures Study
Environmental Restoration Services at Grenade Launcher Range (FTSW-011-R-01) United States Army Garrison Fort Stewart

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Acronyms

Acronym	Definition
APP	Accident Prevention Plan
APT	Armor Piercing Tracer
bgs	Below Ground Surface
CAP	Corrective Action Plan
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	Code of Federal Regulations
CHE	Chemical Warfare Material Hazard Evaluation
CMIP	Corrective Measures Implementation Plan
CMS	Corrective Measures Study
CS	Confirmatory Sampling
CWM	Chemical Warfare Material
DERP	Defense Environmental Restoration Program
DGM	Digital Geophysical Mapping
DMM	Discarded Military Munitions
DoD	Department of Defense
EHE	Explosive Hazard Evaluation
EOD	Explosive Ordnance Disposal
EPA	Environmental Protection Agency
ESS	Explosives Safety Submission
ESV	Ecological Screening Value
ft	Feet
FTSW	Fort Stewart
GAEPD	Georgia Environmental Protection Division
GLR	Grenade Launcher Range
HA	Hazard Assessment
HE	High Explosive
HEAT	High Explosive Anti-Tank
HFD	Hazardous Fragment Distance
HHE	Health Hazard Evaluation
LUCs	Land Use Controls
LUCIP	LUC Implementation Plan
LUCs	Land Use Controls and Surface
MC	Munitions Constituents
MD	Munitions Debris
MEC	Munitions and Explosives of Concern
MMRP	Military Munitions Response Program
MPPEH	Material Potentially Presenting an Explosive Hazard
MRS	Munitions Response Site
msl	Mean Sea Level
N/A	Not Applicable
NCP	National Oil And Hazardous Substances Pollution Contingency Plan
NFA	No Further Action
NOAA	National Oceanic And Atmospheric Administration
O&M	Operation And Maintenance
OB/OD	Open Burn/Open Detonation
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
RSLs	Regional Screening Levels

Acronym	Definition
RTC	Response to Comment
SB	Statement of Basis
SUXOS	Senior Unexploded Ordnance Supervisor
TMV	Toxicity, Mobility, or Volume (of Waste)
TNT	Trinitrotoluene
USAEC	US Army Environmental Command
USAG	United States Army Garrison
USEPA	U.S. Environmental Protection Agency
USGS	United States Geological Survey
UXO	Unexploded Ordnance
UXOSO	Unexploded Ordnance Safety Officer
UXOQCS	Unexploded Ordnance Quality Control Specialist
VSP	Visual Sampling Plan

EXECUTIVE SUMMARY

This report presents a Corrective Measures Study (CMS) in the form of a Corrective Action Plan (CAP) for the Munitions Response Site (MRS) FTSW-011-R-01: Grenade Launcher Range (GLR), hereafter referred to as the Site, at Fort Stewart (FTSW), Georgia. This report is prepared on behalf of the US Army Environmental Command (USAEC) in accordance with Task Order W9124J-19-F-00A4 of Contract No. W9124J-18-D-0008 and FTSW's Resource Conservation and Recovery Act (RCRA) Part B Permit No. HW-045(S)-4, as issued by the Georgia Environmental Protection Division (GAEPD) on August 15, 2017.

The purpose of this document is to outline corrective measures required to address the presence or potential presence of munitions and explosives of concern (MEC) and munitions constituents (MC) at the Site. This document will evaluate a range of actions/alternatives to minimize or eliminate potential risks associated with MEC and MC and, based on this evaluation, select appropriate remedies. A conceptual design, schedule, and cost estimate will also be provided.

FTSW comprises approximately 280,000 acres, and the Garrison Area is located adjacent to Hinesville, Georgia (GA), approximately 40 miles southwest of Savannah, Georgia (Figure 1). The GLR is located in the western portion of the cantonment area, which is the southernmost part of FTSW. The GLR MRS contains land from three overlapping small arms ranges; Ranges A, B, and H, as well as one 120-milimeter (mm) anti-aircraft range that were operational in the 1940s. Range H also included a practice infiltration course. Munitions historically used on these ranges includes 40-mm practice grenades, small arms, blocks of trinitrotoluene (TNT), .30 and .50 caliber machine gun rounds, and 120-mm anti-aircraft projectiles. The ranges extend over a combined 10,948 acres, but the MRS as identified in this report consists of 132 acres in the area reclassified "other than operational" for cantonment expansion. Currently, most of GLR is undeveloped forest and grassland, with existing development comprising warehouses and industrial buildings.

Prior MEC investigations covered the area around the target berms, but recovered no residual MEC associated with 1940's use of the GLR, so the historical use of the range is not considered a source of MEC (CB&I, 2018). However, several munitions associated with more recent use of the range were discovered in a subsurface munitions burial pit near the firing points of the 120-mm projectile range. Several MEC items, including a 90-mm M348 high explosive anti-tank (HEAT) projectile, an AN-M57 250-pound (lb) bomb, and a M106 8-inch high explosive (HE) projectile were discovered in the subsurface, in what is interpreted to be a burial pit first observed in an aerial photograph from 1957. Recovered 25-mm TP-T projectiles of a more recent vintage (post-1970's) identified during the RCRA Facility Investigation (RFI) indicates a material potentially presenting an explosive hazard (MPPEH)/MEC source unrelated to historical use of the range is present on the surface (CB&I, 2018).

The pathways to both subsurface and surface exposure to MEC are considered complete. Previous soil-sampling suggests there is no observed MC hazard associated with the Site (Arcadis/Malcolm Pirnie, 2011; CB&I, 2018), however, further MC sampling may be required in association with MEC in the subsurface related to the burial pit.

GLR is mostly undeveloped forest and grassland, however the developed portions contain warehouses and industrial buildings. There is, accordingly, an unacceptable risk of exposure for workers at the Site to encounter MEC at the surface or for maintenance or construction workers to encounter MEC in the subsurface. Therefore, corrective measures are required to mitigate this risk. The Corrective Measures Study Objectives are to:

- Mitigate human exposure to potential surface and subsurface MEC, such that an acceptable scenario is determined to be present,
- Determine the presence and extent of MC impact, and
- Mitigate potential MC impact in the subsurface.

Corrective measures technologies are being considered for the Site to ensure the protection of current and future receptors from hazards associated with MEC or MC. The choices for technologies for any given site are dependent upon characteristics of the site, costs, access restrictions, as well as future land use and exposure scenarios.

To recommend alternatives that will effectively address the corrective measures objectives described above, each alternative is screened and evaluated based on the following balancing criteria:

1. Long-term Effectiveness;
2. Reduction in Toxicity, Mobility, or Volume (TMV) of Wastes;
3. Short-term Effectiveness;
4. Implementability;
5. Community Acceptance;
6. State acceptance; and
7. Cost Estimate.

Three alternatives are considered in this study: No Action, Land Use Controls (LUCs) and Surface Clearance, and MEC Clearance. Based on the balance of the five above-listed criteria, MEC Clearance is selected as the recommended remedy at the Site.

This alternative is preferred because portions of the Site has been developed for long-term industrial land use with the installation of operations facilities and office buildings, and Alternative 3 provides the most effective reduction in hazard associated with MEC and MC at the Site. Additionally, complete clearance provides a path forward toward a potential NFA, while minimizing land use restrictions.

A MEC Clearance would include a complete surface and subsurface removal of the undeveloped areas of the MRS, utilizing magnetometer-assisted visual survey and/or DGM. Any identified MEC items would be recorded, removed, and disposed of. Removal action would eliminate remaining MEC hazards at or below the ground surface.

The alternative includes MC sampling. At a minimum, representative samples from the on-Site burial pit area after removal action is complete is required. Further sampling, if considered necessary, would be contingent on the depth, nature, and condition of any additional MEC identified during removal action.

Implementation of the MEC Clearance would remove MEC present at or below the ground surface, rendering the pathway to MEC incomplete. The preferred alternative carries the additional benefit of not requiring long term maintenance efforts or costs, and the potential for achieving NFA status .

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1 INTRODUCTION

This report presents a Corrective Measures Study (CMS) in the form of a Corrective Action Plan (CAP) for the Munitions Response Site (MRS) FTSW-011-R-01: Grenade Launcher Range (GLR), hereafter referred to as the Site, at Fort Stewart (FTSW), Georgia. This report is prepared on behalf of the US Army Environmental Command (USAEC) in accordance with Task Order W9124J-19-F-00A4 of Contract No. W9124J-18-D-0008 and FTSW's Resource Conservation and Recovery Act (RCRA) Part B Permit No. HW-045(S)-4, as issued by the Georgia Environmental Protection Division (GAEPD) on August 15, 2017.

The U.S. Department of Defense (DoD) established the Military Munitions Response Program (MMRP) to address DoD sites suspected to contain munitions and explosives of concern (MEC) or munitions constituents (MC). DoD policy states that these responses shall be conducted in accordance with RCRA, CERCLA, and the NCP, as applicable. This site is managed under FTSW's RCRA Part B Permit, and regulated by the GAEPD.

1.1 Purpose

The purpose of this document is to outline corrective measures required to address the presence or potential presence of MEC and MC at the Site. This document will evaluate a range of actions/alternatives to minimize or eliminate potential risks associated with MEC and, based on this evaluation, select appropriate remedies. A conceptual design, schedule, and cost estimate will also be provided.

1.2 Report Organization

Section 1: Introduction

Section 2: Site Characterization and Investigation Results

Section 3: Conceptual Site Model

Section 4: Corrective Measures Objectives and Corrective Action Alternatives

Section 5: Selection of Preferred Alternative

Section 6: References

2 SITE CHARACTERIZATION AND INVESTIGATION RESULTS

2.1 Site Location

FTSW comprises approximately 280,000 acres and the Garrison Area is located adjacent to Hinesville, Georgia (GA), approximately 40 miles southwest of Savannah, Georgia (Figure 1). FTSW is the largest US Army installation east of the Mississippi River and covers portions of Bryan, Evans, Liberty, Long, and Tattnall counties. Georgia State Highways 199 and 144 bisect the installation. The GLR is located in the western portion of the cantonment area, which is the southernmost part of FTSW. A map of the Site is provided as Figure 2.

2.2 Site Description and History

Prior to 1940, FTSW was the Camp Savannah Aircraft Firing Center. The installation was designated Camp Stewart in 1940 in preparation for World War II. The camp supported artillery troop anti-aircraft training, armor and tank training, GA National Guard training, and served as a separation center for redeployed troops. In 1956, Camp Stewart became Fort Stewart, a permanent Army Installation. In 1966, an element of the U.S. Army Aviation School at Fort Rucker, Alabama, was transferred to Fort Stewart, and the focus of FTSW became fixed-wing and helicopter training and gunnery training for the Vietnam War. FTSW is now home to the Third Infantry Division (Mechanized); its current mission is to maintain quality of life, readiness, and provide support for training missions.

The GLR MRS contains land from three overlapping small arms ranges; Ranges A, B, and H, and one 120-mm anti-aircraft range that were operational in the 1940s. Range H also included a practice infiltration course. Munitions historically used on these ranges include 40-mm practice grenades, small arms, blocks of trinitrotoluene (TNT), .30 and .50 caliber machine gun rounds, and 120-mm anti-aircraft projectiles. The ranges extend over a combined 10,948 acres, but the MRS consists of 132 acres in the area recently reclassified “other than operational” for cantonment expansion.

2.3 Environmental Setting

2.3.1 Topography and Physiography

The land beneath FTSW is primarily flat-lying, with surface elevations across most of the installation ranging from approximately 2 to 30 meters above mean sea level (msl). The northwestern portion of FTSW features gently rolling hills with elevations ranging from 30 to 55 meters above msl (Figure 3). Land in the GLR is generally flat to gently sloped toward local drainage features and averages about 6 meters above msl (Arcadis/Malcolm Pirnie, 2011; CB&I, 2018).

The climate at FTSW is classified as humid subtropical, characterized by well-defined seasons with hot, humid summers and mild winters. The National Oceanic and Atmospheric Administration (NOAA) reports the average annual precipitation for Fort Stewart, GA, as 50 inches (NOAA, 2019).

2.3.2 Land Use and Natural Resources

FTSW includes four main types of ecosystems: sand hills, pine flatwoods, upland forests, and wetlands. Just over half of the installation comprises upland forests, which provide habitat to various plants and animals, including game hunted for recreation and human consumption. Roughly a third of the installation is covered by wetlands, including black water swamps, cypress-gum swamps, stream head pocosins, bay forests, and wet pine flatwoods. Approximately 15 percent of the installation is cleared and/or developed land (CB&I, 2018). Except for the habitats provided by forested areas, there are no known site-specific, sensitive ecological or cultural resources at this MRS (Arcadis/Malcolm Pirnie, 2011).

Surface waters at FTSW include various aquatic habitats that provide fish and crustaceans for human consumption, wetlands, and water recreational areas. Surface water features include the Canoochee River, Canoochee Creek and its tributaries, both man-made and natural ponds and lakes, and numerous bottomland swamps and pools.

The GLR is primarily undeveloped forested land and grassland. The developed portion of the MRS contains warehouses and industrial buildings (URS and Arcadis/Malcolm Pirnie, 2013). No changes in land use are currently anticipated or planned (CB&I, 2018).

2.4 Geology

FTSW is located within the Southern Coastal Plain physiographic province. The province comprises a wedge of gently southeast dipping clastic sediments, primarily sand, silt, and clay, overlying crystalline metamorphic basement rock. The unconsolidated sediment wedge thickens to the east, reaching a maximum thickness of approximately 2,300 meters. The metamorphic basement complex ranges from Precambrian to Triassic in age, and dips coastward at about 5.7 meters per kilometer from the Fall Line, near Macon and Augusta, GA, to the Savannah, GA area. (Arcadis/Malcolm Pirnie, 2011).

Soils at FTSW are commonly Ellabelle loamy sand, Ogeechee, Pelham, Stilson, Rutlege, Leefield, and Mascotte. Soils identified on FTSW are described as being poorly-drained. The majority of the soils observed include a sandy surface layer overlying subsurface soil that may consist of sand, clay, loam, or a combination of these. Generally, the surface soils lack cohesive clays and can be prone to erosion, however soils at the MRS are not highly eroded, owing to relatively flat terrain and adequate vegetation (CB&I, 2018).

2.5 Hydrogeology

Coastal Plain strata underly FTSW, including three major aquifer systems. From surface to depth, these are the surficial aquifer system, the Brunswick aquifer system, and the Floridan aquifer system.

The surficial aquifer system comprises interlayered sand, clay, and thin beds of limestone. At FTSW, the surficial aquifer includes an unconfined zone ranging from 20 to 40 feet (ft) below ground surface (bgs) and a deeper, confined zone ranging from 50 to 90 ft bgs. A confining layer of silty clay and dense phosphatic limestone separates the surficial system from the deeper Brunswick aquifer system.

The Brunswick aquifer system comprises upper and lower water-bearing zones of sand and limestone separated by an approximately 70 ft thick confining layer of clay and sand. A confining unit of silty clay and dense phosphatic dolomite separate the Brunswick aquifer system from the deeper Floridan aquifer system.

The Floridan aquifer system comprises relatively permeable carbonate rocks in several water-bearing zones separated by layers of dense, relatively impermeable limestone that act as semi-confining layers. With 20 wells completed in the Floridan system (ranging from 500-800 ft, cased to 400-470 ft), the Floridan aquifer system is the primary source of potable water at FTSW (USGS, 2011; CB&I, 2018).

Groundwater at the GLR is expected to be as shallow as 10 feet. Unnamed drainage features flow to the north on the MRS. There are no known receptors in the MRS. Given the confining layers discussed above, flow between the shallowest aquifer and the deeper aquifers is not anticipated (CB&I, 2018).

2.6 Historical Investigations and Remedial Actions

Historical investigations and remedial actions spanning 2010 through 2018 are summarized in the below subsections.

2.6.1 Confirmatory Sampling

Confirmatory sampling (CS) was performed in August 2010 to determine the presence or absence of MEC and MC impacts associated with historical use of the ranges (Arcadis/Malcolm Pirnie, 2011). The investigation included a magnetometer-assisted visual survey over 10 percent, approximately 4 acres, of the undeveloped portion of the MRS. No MEC was observed during the study, but munitions debris (MD) was observed and the potential for undiscovered MEC in the remaining undeveloped areas could not be ruled out.

Observations made during the survey were used to bias some of the otherwise randomly distributed sample locations for MC assessment. Samples were distributed among the berms and firing points of each of the former ranges, in the infiltration practice course, and near MD identified during the survey. Fourteen discrete samples were taken from the top six inches of soil and analyzed for MC, selected based on munitions known to have been used at the MRS. The samples were analyzed for aluminum, antimony, copper, lead, and zinc by Environmental Protection Agency (EPA) Method 6010B and explosives by EPA Method 8330B Modified.

No metals were detected above their respective USEPA regional screening levels (RSLs), although lead was detected in three samples at concentrations exceeding the ecological screening value (ESV) and in nine samples at concentrations exceeding the background values for FTSW. The detected lead concentration is within an order of magnitude of the Background Value and is considered more likely to be naturally occurring than associated with historical munitions use at the Site. Zinc was detected in two samples at concentrations slightly above background values that did not exceed the RSL or ESV. No explosives were detected at the detection or reporting limits (Arcadis/Malcolm Pirnie, 2011).

2.6.2 RCRA Facility Investigation

A RCRA Facility Investigation (RFI) was conducted at the Site from September 2015 to January 2016, and the final report was approved in March 2018 (CB&I, 2018). The purpose of the RFI was to identify and characterize the nature and extent of MEC hazards and risk to potential receptors in the MRS. Historical record reviews and survey observations showed locations of firing points for each range and target berms on the small arms ranges as well as a disturbed area near the firing point of the 120mm anti-aircraft range, interpreted to potentially represent a burial pit.

Investigations completed during the RFI included analog geophysical transects (mag and dig) over 2.6 acres and a digital geophysical mapping (DGM) survey of 2.4 miles of transects with select anomaly investigation. The magnetometer-assisted visual survey transects were placed around the former grenade target berm locations. The DGM survey was focused on the location of the suspected burial pits around the firing point of the 120-mm anti-aircraft range.

During the mag and dig survey, all anomalies were intrusively investigated and no evidence of 40-mm grenades was observed. One inert training mine (inconsistent with historical range use) and six good-condition, unfired 25-mm TP-T projectiles of post 1970s vintage were recovered. The practice mine was discovered at 2-inches bgs and classified as MD. The 25-mm TP-T projectiles were discovered along the bank of a runoff ditch and classified as material potentially presenting an explosive hazard (MPPEH) (CB&I, 2018). These were associated with recent disposal, rather than historic range activity.

For the purposes of this CMS, the discarded 25-mm TP-T projectiles, found as complete rounds and classified in the 2018 RFI as MPPEH (CB&I, 2018), will be considered MEC items. Although it is not considered associated with the historical use of the range, the presence of MEC at the MRS must be addressed.

The DGM survey was run with 25 ft spacing and focused on the potential burial pit observed in aerial photographs from 1957. One hundred and four DGM anomalies were identified, 92 of which had footprints greater than three feet and are interpreted to potentially represent multiple buried objects. Visual Sampling Plan's (VSP) "Anomaly Sampling for unexploded ordnance (UXO)" module model analysis suggested that if 44 of the 92 anomalies were randomly selected, investigated, and found to not contain MEC, then the RFI reported it could be stated with 95% confidence that 95% of the targets would not contain MEC (CB&I, 2018).

Forty-three of the forty-four anomalies did not contain MEC. MD was recovered at some of these locations including a 57-mm M70 armor-piercing tracer (APT) projectile, M49 flare, frag pieces, fuzes, and other assorted MD components. The one anomaly that did contain MEC was determined to represent a burial pit. Explosive Ordnance Disposal (EOD) was contacted to remove and dispose of a 90-mm M348 high explosive anti-tank (HEAT) projectile, an AN-M57 250-pound general purpose bomb, and an 8-inch M106 high explosive (HE) projectile. Further investigation of the burial pit was determined to be beyond the scope of the RFI. MC samples could not be safely collected from the burial pit, owing to the probable presence of more MEC. Items recovered are summarized in Table 2-1.

Table 2-1 Summary of Items Recovered at Grenade Launcher Range

Source	Item Recovered	Quantity	Classification	Depth
Confirmation Sampling (Arcadis/Malcolm Pirnie, 2011)	None	-	N/A	N/A
RFI- Mag and Dig Transects (CB&I, 2018)	Training Mine	1	MD	Surface
	25-mm TP Projectile (with cartridges intact) *	6	MPPEH/MEC	Surface
RFI- DGM Survey (CB&I, 2018)	90-mm HEAT Projectile (M348)	1	MEC	6"
	250-lb Bomb (AN-M57)	1	MEC	40"
	8-inch HE Projectile (M106)	1	MEC	48"
	57-mm M70 APT Projectile	1	MD	3"
	Locations w/ Assorted MD and/or Frag	7	MD	3" to 12"

*Not associated with historical GLR activities (post-1970 vintage)

During the RFI, MEC was only discovered in the munitions burial pit near the 120-mm firing points. There is a potential for more MEC to be uncovered with further investigation of the burial pit.

2.7 MEC Hazard Assessment

A MEC Hazard Assessment (HA) was completed for the GLR as a component of the 2018 RFI (CB&I 2018). The HA was based on 2008 USEPA Interim MEC HA Methodology, which evaluates the potential explosive hazard associated with conventional MEC present at an MRS under a variety of site conditions. This method considers various clean up scenarios and land-use assumptions, but does not address explosive or toxic hazards associated with chemical warfare materiel, underwater MEC, nor non-explosive hazards (e.g. environmental) that may be associated with MEC.

The MEC HA was structured into three components: severity, accessibility, and sensitivity. These categories each incorporate two or more input factors that are each given a numeric score. These scores are added to calculate a hazard level. Hazard levels are ranked 1 to 4 with higher numbers corresponding to lower potential explosive hazards.

Table 2-2 MEC Hazard Assessment Scores

Hazard Level	Minimum MEC HA Score	Maximum MEC HA Score	Description
1	840	1000	Highest potential explosive hazard condition
2	725	835	High potential explosive hazard condition
3	530	720	Moderate potential explosive hazard condition
4	125	525	Low potential explosive hazard condition

2.7.1 Severity

The MEC HA defines severity as, "[t]he potential consequences of the effect (e.g. injury or death) on a human receptor should a MEC item detonate." Both primary and secondary receptors are taken into consideration in this assessment. Severity is based on the energetic material type and location of human receptors.

The recovery of an AN-M57 250-lb bomb, an 8-inch M106 HE projectile, and a 90-mm M384 HE projectile determined the energetic material type at GLR to be high explosive (HE). According to the DoD fragmentation database, the greatest hazardous fragment distance (HFD) for these is 389-feet for the 8-inch M106 HE projectile. Areas within the MRS and within 389 feet of the boundary of the MRS where humans are likely to congregate are considered in the analysis. These include facility offices and warehouses. There are no current plans to change land use at GLR, and the location of human receptors is considered unlikely to change (CB&I, 2018).

2.7.2 Accessibility

MEC HA guidance defines accessibility as, "[t]he likelihood that a human receptor will be able to come into contact with a MEC item." Accessibility considers site accessibility, potential contact hours, amount of MEC, minimum MEC depth relative to the maximum receptor intrusive depth, and migration potential. GLR is accessible by people with access to FTSW, with no fences or posted signage, so it is considered to have "Full Accessibility."

Potential contact hours are the estimated potential contact hours per year, and are based on normal operating activities for construction/maintenance worker, warehouse personnel, and office workers at the MRS. With approximately 320 people working 40 hours a week for 50 weeks a year, these were estimated to be 601,600 hours- categorized as "some" hours according to MEC HA guidance.

The amount of MEC is a qualitative category for estimated quantities of MEC expected to be in an area (e.g. open burn/open detonation [OB/OD] area, firing points, burial pit, safety buffer area, storage, etc.) Based on historical records, the majority of GLR was used as firing points for small arms and grenade launchers. No MEC source is associated with these activities. Based on the RFI investigation, however, a portion of the Site was also used as a burial pit for munitions. Therefore, "Burial Pit" was selected to describe the GLR. "Burial Pits" correspond to concentrated quantities of MEC items.

The minimum MEC depth relative to maximum receptor intrusive depth input characterizes the likelihood of a receptor interacting with potential MEC. MEC identified in the RFI at the GLR were located in the

subsurface. The depth of burial in the burial pit is assumed to be directly below the ground surface. Intrusive activities are expected to occur within the upper four feet of subsurface for utility work, construction, etc.

Migration potential describes the likelihood that MEC items can be moved and exposed by natural processes including erosion and frost-heaving. Climate and topography at the MRS determined this input factor to be "not probable" (CB&I, 2018).

2.7.3 Sensitivity

MEC HA guidance defines sensitivity as, "the likelihood that a MEC item will detonate if a human receptor interacts with it." Sensitivity is determined using MEC classification and MEC size.

MEC classification is given as six categories: UXO Special Case, UXO, Fuzed Discarded Military Munitions (DMM) Special Case, Fuzed DMM, Unfuzed DMM, and Bulk Explosives. The MEC discovered in the burial pit during the RFI were classified as "Unfuzed DMM."

MEC size is used to account for the ease with which a receptor could move the MEC. Smaller, more portable items are more likely to be picked up and disturbed by a potential receptor. MEC is classified as "small" (less than 90-lbs) or "large" (greater than 90-lbs), and if any of the MEC reported is less than 90-lbs, then "small" must be used as the input for analysis. MEC items weighing less than 90-lbs were recovered at the MRS, so "small" was used in the HA as the input (CB&I, 2018).

2.7.4 MEC HA Results

The input factors, as discussed in Sections 2.7.1 through 2.7.3, were used in the MEC HA automated workbook. Based on current conditions as known at the Site and the current use scenario, the MEC HA methodology yielded a score of 665, and a Hazard Level of 3 (moderate potential explosive hazard condition) (CB&I, 2018).

3 CONCEPTUAL SITE MODEL

3.1 Source

Section 2.6.2 describes the source of MEC investigated during the 2018 RFI. In this model, the source contamination consists of MEC discovered in the subsurface.

3.2 Interaction

MPPEH/MEC discovered at GLR was found at the surface. A receptor walking on the former GLR site may contact MEC on the ground surface. MEC discovered at GLR was also found in the subsurface. A receptor may contact MEC in the subsurface while performing construction, landscaping, or other intrusive activities at the burial pit.

3.3 Receptors

The GLR is within a recently developed, but still partly forested area, on the west side of the cantonment area. The MRS comprises warehouses and office facilities. No changes in land use are currently anticipated or planned. Receptors considered for MEC/MPPEH at the GLR are:

- Indoor Facility Workers who occupy FTSW buildings for work purposes
- Maintenance and Construction Workers who may perform landscaping, grounds keeping, or excavation activities
- Visitors who may access and walk through the area

Any of these receptors are expected to walk around the MRS and could potentially encounter MEC on the surface. The maintenance and construction workers may perform activities that involve earth moving and encounter subsurface MEC at the burial pit.

3.4 MC

No MC above RSLs was discovered during Confirmatory Sampling (Arcadis/Malcolm Pirnie, 2011). MC investigation related to the burial pit uncovered in the RFI could not safely be completed with MEC remaining in the burial pit (CB&I, 2018).

MC is potentially released to the soil when munitions with sufficient quantities of MC are breached. There is a potential for MC to be present in soil in or under the burial pit at the GLR. The munitions removed from the burial pit during the RFI were in good condition and did not appear to have been breached, so the potential for MC release is considered low (CB&I, 2018). However, the presence or condition of remaining MEC in the burial pit is unknown. Characterization of soil under the burial pit cannot be safely or adequately performed until MEC removal is complete and recovered MEC are inspected for evidence of breach/release. The pathway of exposure for construction/maintenance workers is potentially complete via dermal contact and incidental ingestion, should an excavation occur and MC be present in soil.

If munitions casings are breached and enough MC is released to soil, then there is a chance of precipitation infiltration facilitating contaminant mobility into the surficial (non-potable) groundwater aquifer. The surficial aquifer is expected to be as shallow as 10 ft bgs at the MRS. The topography at GLR is flat to gently sloping. The sloping topography trends in a direction towards unnamed drainage features to the north (Figure 3). Receptor contact with groundwater is possible if excavations or construction activities disturb soil to a depth at or below the water table.

Receptor contact with groundwater as a drinking water source is considered an incomplete pathway. The surficial aquifer is not a potable water source. Unconfined groundwater in this aquifer is expected to follow topography to the northwest into the aerially extensive operational ranges of FTSW. There are no receptors in the operational area of FTSW. As discussed in Section 2.5, numerous confining layers between the aquifers are expected to preclude flow from the shallow aquifer to the deeper aquifers (CB&I, 2018).

4 CORRECTIVE MEASURES OBJECTIVES AND CORRECTIVE ACTION ALTERNATIVES

4.1 Establishment of Corrective Measures Objectives

Previous investigations confirm the presence of MEC at the MRS. GLR is mostly undeveloped forest and grassland, however the developed portions contain warehouses and industrial buildings. There is, accordingly, an unacceptable risk of exposure for workers at the site to encounter MEC at the surface, or for maintenance or construction workers to encounter MEC in the subsurface. Therefore, corrective measures are required to mitigate this risk. The corrective measures objectives are to:

- Mitigate human exposure to potential surface and subsurface MEC (to the depth of detection), such that an acceptable scenario is determined to be present,
- Determine presence and extent of MC impact, and
- Mitigate potential MC impact in the subsurface.

Based on results of the RFI, the analysis of existing data used to evaluate the extent of MEC and exposure pathways to MEC in the surface and subsurface, a CMS is required to address MEC and potential MC at the Site pursuant to the corrective measures objectives.

4.2 Establishment of Corrective Action Alternatives

Corrective measures technologies are being considered for the Site to ensure the protection of current and future receptors from hazards associated with MEC or MC. The choices for technologies for any given site are dependent upon characteristics of the site, costs, access restrictions, as well as future land use and exposure scenarios.

To recommend alternatives that will effectively address the corrective measures objectives described above, each alternative will be screened and evaluated based on the following balancing criteria:

1. Long-term Effectiveness
2. Reduction in the TMV of Wastes.
3. Short-term Effectiveness
4. Implementability
5. Community Acceptance
6. State Acceptance
7. Cost Estimate.

Such a recommendation shall include a description and supporting rational for the proposed remedy, including how it will achieve the clean-up objectives and the proposed remedy's relationship to the balancing criteria.

In accordance with the RCRA permit for FTSW and utilizing USEPA Guidance on RCRA Corrective Action Decisions Documents (EPA/540/G-91/011; USEPA, 1991), all alternatives will require the preparation of a Statement of Basis (SB) document. The SB will undergo a Public Comment Period followed by the preparation of a response to comment (RTC) document. Additional aspects of the individual corrective measures alternatives are detailed in the following sections.

Three alternatives were selected for evaluation for AAR-4A:

1. No Action
2. Land Use Controls with MEC Surface Clearance
3. MEC Clearance

In the following subsections, these three alternatives are evaluated using the balancing criteria. A summary of the balancing criteria evaluation is presented in Table 4-1.

Table 4-1 Summary of Balancing Criteria

Alternatives	Long-Term Effectiveness	Reduces TMV	Short-Term Effectiveness	Implementability	Cost Estimate
No Action	Ineffective	Ineffective	Ineffective	High Ease	$18,144
Land Use Controls and Surface MEC Clearance	Effective	Effective	Effective	Moderate Ease	$504,212
MEC Clearance	Effective	Effective	Effective	Low Ease	$1,299,030

4.2.1 Alternative 1 – No Action

Alternative 1 takes a "No Action" approach as a Corrective Action Alternative. No Action does not require the use of technologies associated with a response action. This option does not include institutional controls or action to control, treat, remove or dispose of MEC or MC associated with the Site. The balancing criteria for Alternative 1 are described below.

Long-term Effectiveness
Alternative 1 does not effectively address site risk for the long-term. Since the Site has been determined to have moderate explosive risk, Alternative 1 would not address the hazardous risk under analogous site conditions over an extended period of time.

Reduces TMV of Waste
Alternative 1's "No Action" approach does not reduce the volume of MEC or MC or alter the pathway through which humans may be exposed to MEC or MC.

Short-term Effectiveness
Alternative 1 does not effectively address site risk for the short-term. Since the Site has been determined to have moderate explosive risk and the Site currently has a population with a moderate risk of encountering MEC or MC, Alternative 1 does nothing to mitigated the unacceptable risk to receptors.

Implementability
Alternative 1 is highly implementable and requires no effort beyond the SB. No additional administrative activities are required, no time is required to implement, and no technologies are required to implement the alternative.

Community Acceptance
Community Acceptance of Alternative 1 is unlikely. It is improbable that the community will accept "No Action" towards mitigating potential explosive hazards.

State Acceptance
State Acceptance of Alternative 1 by is unlikely. The "No Action" approach is not sufficient in mitigating potential explosive hazards.

Cost Estimate
Alternative 1 is considered a low-cost alternative for the Site, incorporating only the cost for the SB. The estimated cost to implement this alternative is $18,144. Support for this estimate is provided in Appendix A.

Alternative 1 is not an effective approach at reducing the exposure of humans to MEC or MC related hazards through the means of inaction. Alternative 1 is not retained for the Site.

4.2.2 Alternative 2 – Land Use Controls and MEC Surface Clearance

Land use controls (LUCs) include such actions as land use restrictions and access restrictions to reduce the potential exposure to MEC and MC. LUCs include engineered and non-engineered instruments such as physical barriers containing the hazardous contamination, or to prevent access to contaminated locations, as well as legal and/or administrative controls that minimize the potential for human exposure to MEC or MC by limiting the use of the land. LUCs would require monitoring of engineered and institutional controls through periodic inspections and reporting on a regular basis.

Alternative 2 includes installing fencing and signage around the burial pit area identified in the 2018 RFI to restrict access to remaining subsurface MEC or potential MC associated with the pit, and installing signage around any other remaining undeveloped or uninvestigated areas at the MRS, as shown in Figure 4. LUCs would meet guidelines outlined in the DoD Policy on LUCs Associated with Environmental Restoration Activities (DoD, 2011). Institutional controls would include requiring approval for permission to dig in the MRS and would not allow intrusive activities in the area of the burial pit without prior removal action.

Because the pathway to MEC at the surface of the GLR is considered complete and the area is currently openly accessible to human receptors as discussed in Section 3.3, a MEC surface sweep and removal is considered in order to identify and remove potential MEC at the surface.

A MEC Clearance would be conducted by qualified UXO and geophysical personnel, who would safely and properly identify and remove MEC at the surface. The clearance would be completed using analog magnetometers in areas that have not already been disturbed for development. MEC discovered would be removed and safely disposed of. The areas of the Site that are not known to have previously been disturbed for development are shown in Figure 4, and cover a total of approximately 44 acres.

Long-term Effectiveness
Alternative 2 is effective in the long-term by providing empirical data on the location, disposition, and disposal of potential MEC items at the surface. These items would then be disposed of and removed, and mitigating the unacceptable risk at the ground surface.

Alternative 2 is also effective in the long-term by restricting access to potential MEC or MC in the subsurface through engineered and institutional controls, preventing impermissible access to untrained personnel in the potentially MEC affected subsurface area.

Reduces Toxicity, Mobility, or Volume of Waste
Alternative 2 is an effective approach to reducing the volume of MEC or MC to which receptors may be exposed, by reducing volume of potential MEC at the surface, and by physically restricting access to MEC

or MC in the subsurface. Institutional controls are maximized when implemented alongside engineering controls like fencing and signage. Potential MC in the subsurface has not been ruled out in the burial pit area, and while Alternative 2 does prevent direct human exposure to potential MC, it does not reduce the toxicity or mobility of potential MC in the subsurface.

Short-term Effectiveness

Alternative 2 is effective in the subsurface pathway by preventing unintentional access to MEC in the subsurface with installation of fencing and signage. Alternative 2 will be effective on the surface upon completion of the surface sweep and removal action.

Implementability

Alternative 2 is implementable with moderate ease, relative to other alternatives. Administrative activities would be required to implement this corrective measure, in the form of updates to the base-wide Master Plan, and generation and approval of the necessary planning documents (e.g. CMIP that includes LUC Implementation Plan [LUCIP], Surface Removal plan, Accident Prevention Plan [APP], and Explosive Safety Submission [ESS]). Construction of Alternative 2 requires the installation of approximately 5,250 linear feet of fencing and the installation of up to 72 numbered signs not farther than 200 feet apart. UXO personnel would provide construction support during fence installation. Fencing and signage would need to be surveyed and submitted to FTSWs Geographic Information Systems. Sign verbiage would require approval from the installation and the GAEPD. Annual inspections, maintenance, and repair to the physical LUCs would be required until base closure or until remaining MEC/MC is otherwise remedied. Fencing and signage is not difficult or prohibitively expensive to acquire or install, and no scarce materials or technology are required for implementation of this alternative.

The surface removal action and fence installation would require a team of qualified UXO professionals, and additional consideration will need to be taken for safe and proper disposal of any MEC items recovered during the removal action. Technologies required would include analog magnetometers for the surface clearance. The surface clearance would cover the remaining undeveloped areas of the MRS. This constitutes an estimated 44 acres, as shown on Figure 4.

Community Acceptance

Community Acceptance of Alternative 2 is not unlikely. Because Alternative 2 does reduce potential for human exposure to explosive hazards and does not restrict public access to large portions of hunting land, acceptance of Alternative 2 is probable.

State Acceptance

State Acceptance of Alternative 2 is not guaranteed. While Alternative 2 does reduce potential for human interaction with known or potential MEC at the surface and in the subsurface, it does not reduce the potential toxicity or mobility for potential MC in the subsurface associated with the burial pit.

Cost Estimate

Alternative 2 is considered as the moderate cost alternative for this Site. The estimated cost to implement this alternative is $504,212. Support for this estimate is provided in Appendix A. For the purpose of cost-to-completion estimates, Army protocol dictates a period of 30 years be used to account for long term O&M of LUCs if no definitive closure date is known. While 30 years will be used for cost estimates, LUCs, if implemented, will be maintained until base closure or MEC at the site is otherwise remedied.

Alternative 2 is effective at reducing the exposure of humans to MEC or MC related hazards. However, Alternative 2 does not reduce the toxicity or mobility of potential MC in the subsurface. Alternative 2 is not retained for this Site.

4.2.3 Alternative 3- MEC Clearance

Alternative 3 includes the Surface Clearance discussed above in Alternative 2, Section 4.2.2, along with an additional subsurface clearance. The surface clearance would render the surface pathway of MEC to human receptors incomplete. Removal of remaining MEC in the subsurface would remove the identified subsurface MEC hazards, as well as any others not previously identified, and remove these from the MEC HA. Alternative 3 has the potential to result in an NFA, while minimizing land use restrictions. The removal action would cover the same estimated 44 acre-area cleared in the surface sweep (Figure 5).

Alternative 3 additionally includes MC sampling, the amount and extent of which is contingent upon the nature, depth, and condition of any MEC discovered during the removal action. MC sampling could not be completed in the burial pit area during the RFI on account of the safety hazard associated with the remaining MEC in the burial pit. At a minimum, MC sampling will be required from areas of already identified MEC in the burial pit area. An approach similar to the planned MC sampling for the RFI would be appropriate.

Long-term Effectiveness
Alternative 3 is the most effective in the long-term by providing empirical data on the location, disposition, and disposal of potential MEC items both on the surface and in the subsurface. These items would then be disposed of, thus mitigating the unacceptable risk. Alternative 3 also allows for the identification and mitigation of potential MC in the subsurface. NFA status could potentially be achieved for the Site, therefore, Alternative 3 would be very effective in the long-term.

Reduces TMV of Waste
Alternative 3 would provide the greatest level of reduction of TMV of waste by removing MEC from the surface and subsurface, and mitigating potential MC in the subsurface.

Short-term Effectiveness
Alternative 3 is moderately effective in the short term. Access would need to be temporarily restricted in conjunction with the removal activities in the event that additional MEC items are discovered and require removal.

Implementability
Alternative 3 is moderately difficult to implement, relative to other alternatives. The alternative would require administrative efforts including preparation of necessary planning documents (e.g. CMIP, APP, and ESS) for the removal action. The removal action would require a team of UXO technicians, a Senior UXO Supervisor (SUXOS), UXO Quality Control Specialist (UXOQCS), and a UXO Safety Officer (UXOSO). MEC recovered would require safe and proper disposal. Technologies required would include analog magnetometers for the surface sweep, and DGM using EM61 or equivalent technology for the subsurface removal. Both the surface and subsurface removal would cover the entirety of the MRS that has not already been disturbed during development. This includes an estimated 44 acres (Figure 5). Subsurface investigation would require clearing vegetation of much of the remaining wooded area in the MRS to facilitate DGM data collection. MC sampling would require, at minimum, representative samples from the burial pit area after removal action is complete. Further sampling would be contingent on the depth, nature, and condition of any additional MEC identified during removal action.

Community Acceptance
Alternative 3 is likely to be accepted by the community. Alternative 3 is the most effective at mitigating the risk of human exposure to potential explosive hazard.

State Acceptance

Alternative 3 is likely to be accepted by the State. Alternative 3 is the most effective alternative in mitigating the risk of exposure of potential explosive hazard. Alternative 3 also includes sampling for MC, which will lead to remediation if required. This is the only alternative that reduces the toxicity, mobility, and volume of potential MC in the subsurface.

Cost Estimate

Alternative 3 is considered the "high" cost alternative for this Site. The estimated cost to implement this alternative is $1,299,030. Support for this estimate is provided in Appendix A.

Alternative 3 is the most effective as reducing the exposure of humans to MEC and MC related hazards, and could potentially result in NFA status, with the fewest long-term land use restrictions. Alternative 3 is retained for the Site.

5 SELECTION OF PREFERRED ALTERNATIVE

5.1 Preferred Alternative

Based on the assessment of the alternatives described in the previous section, the preferred alternative for this site is Alternative 3- MEC Clearance. This alternative is preferred because the Site has been developed for long-term industrial land use with the installation of operations facilities and office buildings, and Alternative 3 provides the most effective reduction in hazard associated with MEC and MC at the Site. Additionally, Alternative 3 results in the fewest long-term land use restrictions while still mitigating exposure to MEC and MC.

Identifying and removing MEC is the very effective in preventing unintentional contact between human receptors walking around the MRS, or those performing any intrusive activities, and MEC.

Implementation would require the preparation and approval of the appropriate planning documents (e.g. CMIP, APP, ESS) prior to mobilization for the removal effort. The MEC Clearance requires a team of UXO technicians, a SUXOS, UXOQCS, and UXOSO. The MEC Clearance would cover the entirety of the undeveloped areas of the MRS, an estimated 44 acres (Figure 5) to the depth of detection. MEC recovered would require safe and proper disposal. Technologies required would include analog magnetometers for surface sweep, and DGM using EM61 or equivalent technology for subsurface removal. Subsurface investigation would require clearing vegetation of much of the remaining wooded area in the MRS to facilitate DGM data collection. MC sampling would require, at minimum, representative samples from the burial pit area after removal action is complete. Further sampling would be contingent on the depth, nature, and condition of any additional MEC identified during removal action.

Implementation of the Alternative 3 will remove MEC present at or below the surface of the MRS, rendering the pathway to MEC in both the surface and subsurface incomplete. The pathway to MC can be re-evaluated based on the results of further MC sampling. Alternative 3 could potentially result in and NFA status for the Site.

5.2 Precedence in Support of the Preferred Alternative

Surface and subsurface MEC clearance utilizing mag/dig surveys and/or DGM are industry standard techniques in MMRP site remediation.

5.3 Schedule

It is estimated that the preparation and approval of CMIP/LUCIP documents will take nine months. Preparation and approval of the APP/ESS documents is estimated to take three months. Procurement and mobilization for the MEC clearance is estimated to take one month. The surface clearance is estimated to take two weeks. The subsurface clearance is estimated to take seven weeks. Demobilization is estimated to take half a month. Reporting after the field effort is expected to take six months. These are estimates and the actual schedule may vary.

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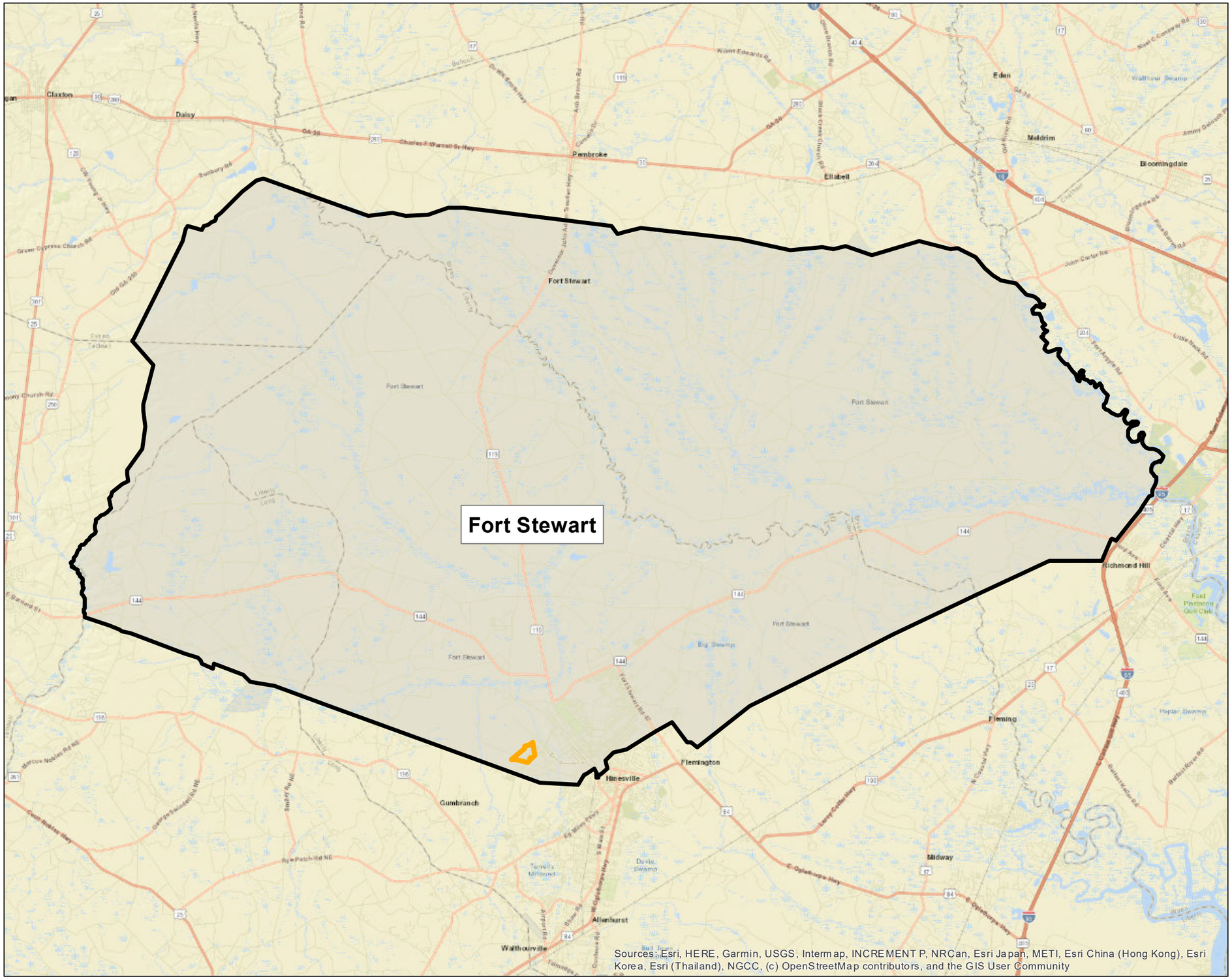
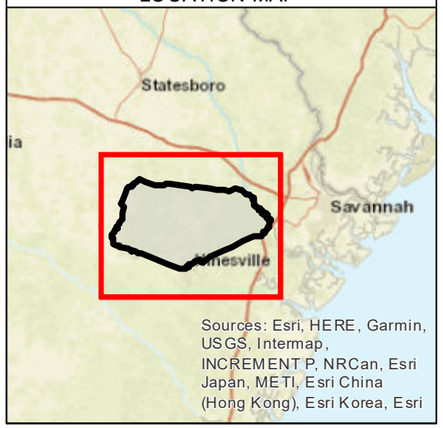
Figures



LEGEND

- Installation Boundary
- Grenade Launcher Range

LOCATION MAP



NOTES & SOURCES

Map Coordinates: WGS 1984, UTM Zone 17N (US Feet)

0 2.5 5

Miles

TITLE

Installation Map and Site Location

KEMRON ENVIRONMENTAL SERVICES — Fort Stewart

PROJECT: U.S. Army Garrison - Fort Stewart
Directorate of Public Works
1550 Veterans Parkway Building 1137
USAG Fort Stewart, Georgia 31314

DRAWING DATE: 4/24/2020

Drawn by:	Reviewed by:
CJ	MSC

N

FIGURE 1

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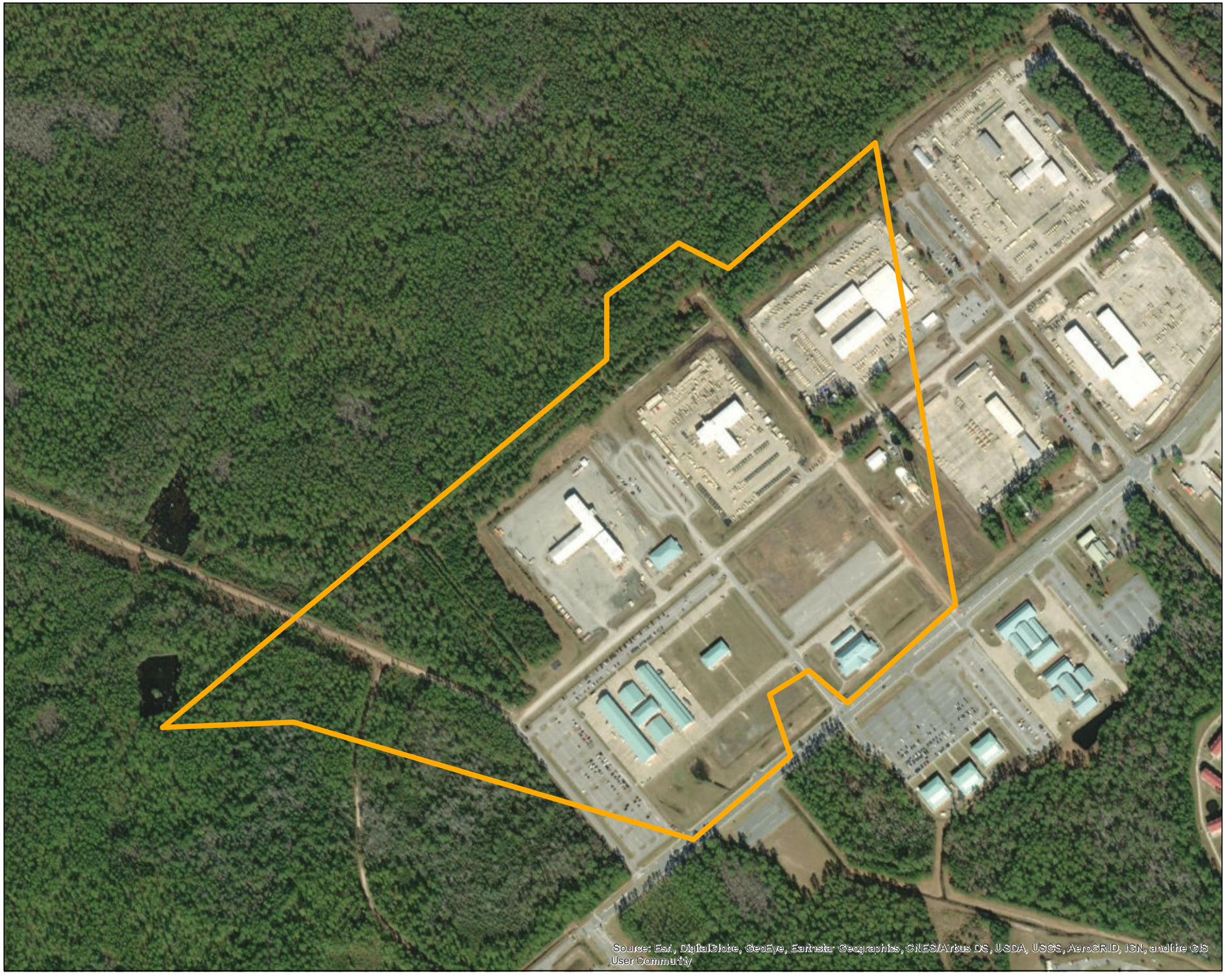
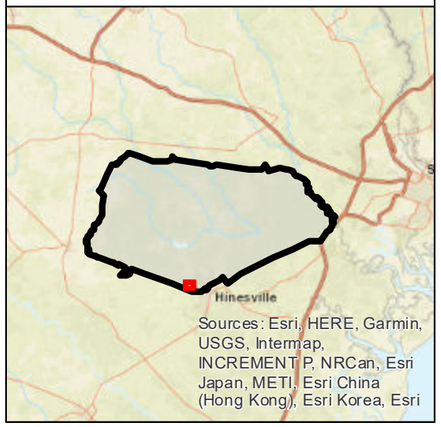


LEGEND

Grenade Launcher Range

Installation Boundary

LOCATION MAP



NOTES & SOURCES

Map Coordinates: WGS 1984, UTM Zone 17N (US Feet)

0 500 1,000

Feet

TITLE

Grenade Launcher Range Site Map

KEMRON ENVIRONMENTAL SERVICES — Fort Stewart

PROJECT: U.S. Army Garrison - Fort Stewart
Directorate of Public Works
1550 Veterans Parkway Building 1137
USAG Fort Stewart, Georgia 31314

DRAWING DATE: 12/7/2019

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FIGURE

2

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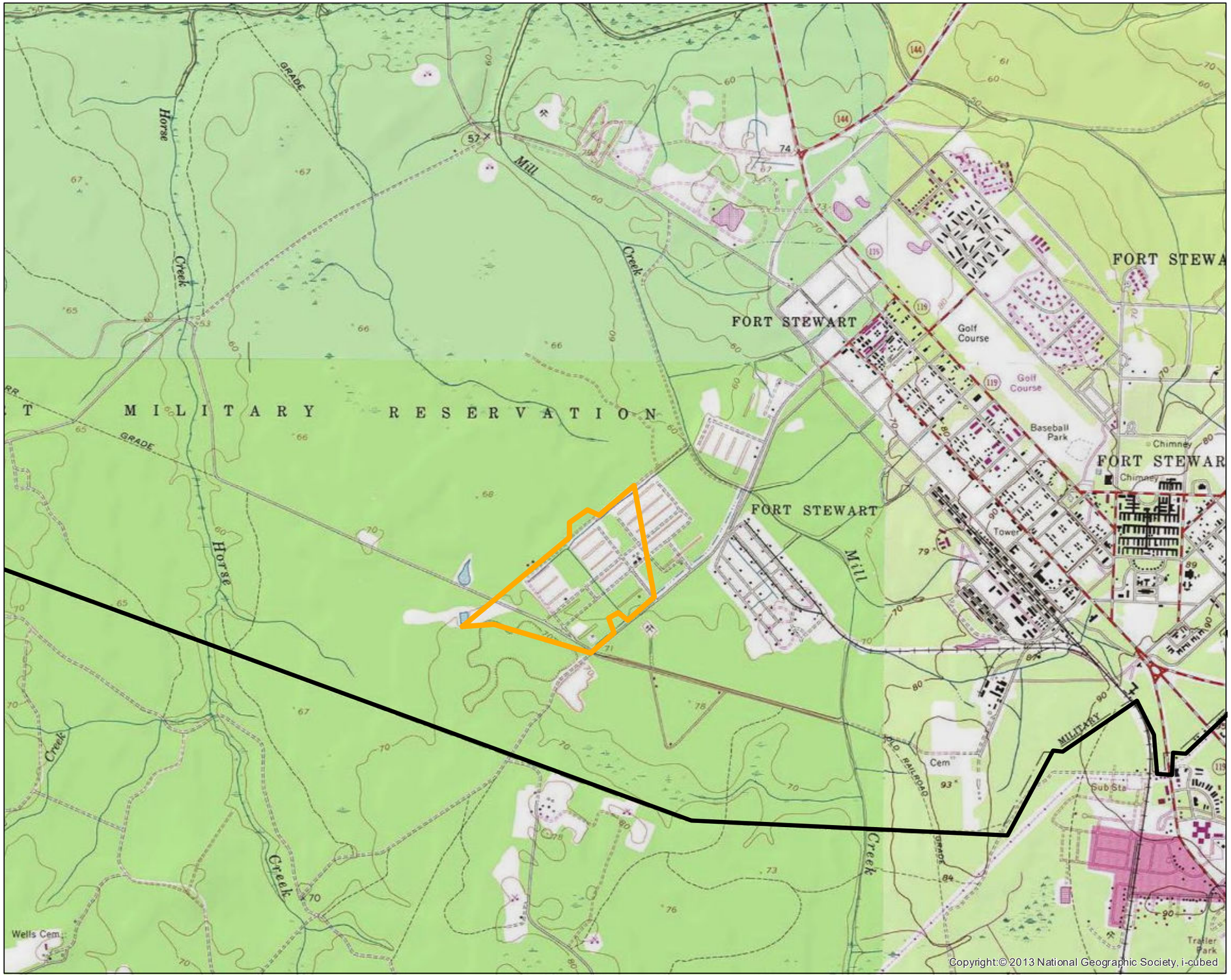
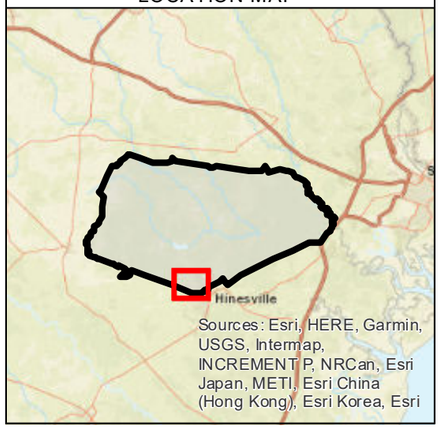


LEGEND

Grenade Launcher Range

Installation Boundary

LOCATION MAP



NOTES & SOURCES

Map Coordinates: WGS 1984, UTM Zone 17N (US Feet)

0 0.25 0.5

Miles

TITLE

Grenade Launcher Range Topography

KEMRON ENVIRONMENTAL SERVICES — Fort Stewart

PROJECT: U.S. Army Garrison - Fort Stewart
Directorate of Public Works
1550 Veterans Parkway Building 1137
USAG Fort Stewart, Georgia 31314

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N

FIGURE

3

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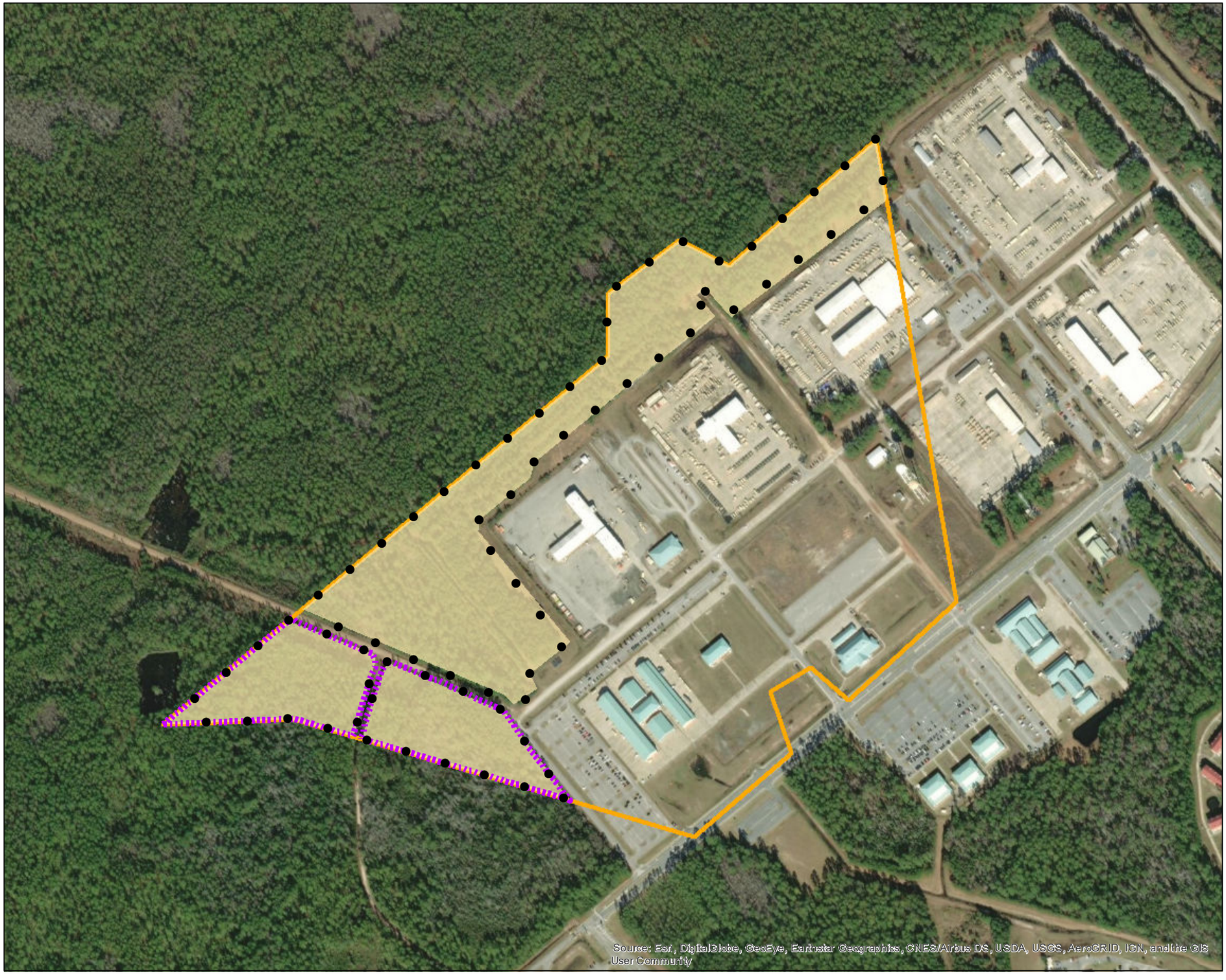
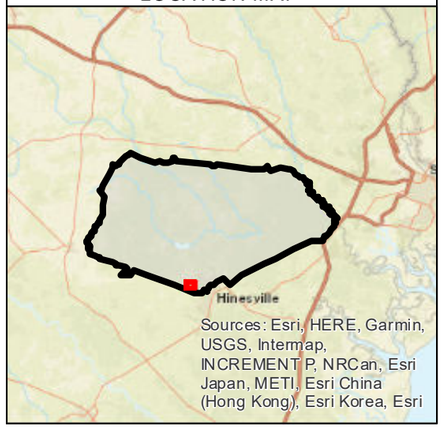


LEGEND

- Grenade Launcher Range
- Area to Be Cleared
- Signs
- Fencing
- Installation Boundary

LOCATION MAP



NOTES & SOURCES

Map Coordinates: WGS 1984, UTM Zone 17N (US Feet)

Sign placement based on 200 ft spacing. Areas to be cleared are those that have not been disturbed for development.

0 500 1,000

Feet

TITLE

Grenade Launcher Range Alternative 2 LUCs and MEC Surface Clearance

KEMRON ENVIRONMENTAL SERVICES — Fort Stewart

PROJECT: U.S. Army Garrison - Fort Stewart
Directorate of Public Works
1550 Veterans Parkway Building 1137
USAG Fort Stewart, Georgia 31314

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CJ	MSC

N

FIGURE

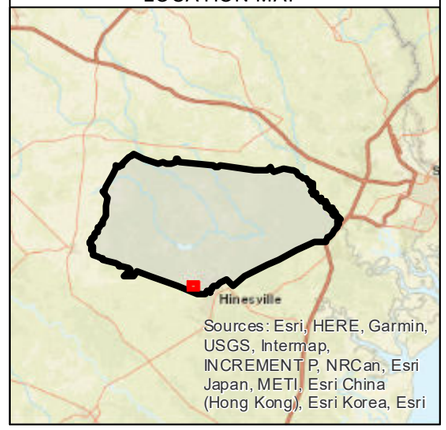
4

Document Path: M:\GIS\SH4943 - Ft Stewart Hunter Army Airfield\Fort Stewart\MXDs\GLR\4-GLR_Alternative2.mxd

LEGEND

- Grenade Launcher Range
- Area to Be Cleared
- Installation Boundary

LOCATION MAP



NOTES & SOURCES

Map Coordinates: WGS 1984, UTM Zone 17N (US Feet)

Areas to be cleared are those that have not been disturbed for development

0 500 1,000

Feet

TITLE

Grenade Launcher Range
Alternative 3
MEC Clearance

KEMRON ENVIRONMENTAL SERVICES — Fort Stewart

PROJECT: U.S. Army Garrison - Fort Stewart
Directorate of Public Works
1550 Veterans Parkway Building 1137
USAG Fort Stewart, Georgia 31314

DRAWING DATE: 12/7/2019

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CJ	MSC

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FIGURE

5

Document Path: M:\GIS\SH4943 - Ft Stewart Hunter Army Airfield\Fort Stewart\MXDs\GLR\5-GLR_Alternative3.mxd

Appendix A – Support for Cost Estimate

Table A-1: Grenade Launcher Range
Alternative 1: No Action

Capital Costs					
Description	**Quantity**	**Units**	**Unit Cost**	**Total Cost**	**Notes/Assumptions**
Statement of Basis					
Statement of Basis and Response to Comments	1	LS	$15,000	$15,000	Includes Public Review and Meeting
SUBTOTAL (Statement of Basis)				$15,000	
Contingency (% of Sum)	12%			$1,800	
Project Management (% of Sum + Cont.)	8%			$1,344	
Total Capital Cost				**$18,144**	

Annual Costs
There are no annual costs associated with this Alternative

Periodic Costs
There are no periodic costs associated with this Alternative

Present Value Analysis					
Cost Type	**Year**	**Total Cost**	**Total Cost Per Year**	**Discount Factor (7%)**	**Present Value**
Capital	0	$18,144	$18,144	1.000	$18,144
Annual	1-30	$0	$0	12.409	$0
Periodic	NA	$0	$0	NA	$0
Total Present Value of Alternative					**$18,144**

Table A-2: Grenade Launcher Range
Alternative 2: Land Use Controls and MEC Surface Clearance

Capital Costs					
Description	**Quantity**	**Units**	**Unit Cost**	**Total Cost**	**Notes/Assumptions**
Statement of Basis					
Statement of Basis and Response to Comments	1	LS	$15,000	$15,000	Includes Public Review, Meeting, and Document Finalization
SUBTOTAL (Statement of Basis)				$15,000	
Land Use Controls					
Land Use Control Implementation Plan	1	LS	$20,000	$20,000	Includes design and placement of fence and signs, details required institutional controls
Fence and Sign Installation	1	LS	$22,700	$22,700	Install fence around disposal pit area and signs around AOC
Institutional Controls	1	LS	$15,000	$15,000	Incorporating land use restrictions into all applicable documents
SUBTOTAL (Land Use Controls)				$57,700	
MEC Surface Clearance					
Planning Documents	1	LS	$25,000	$25,000	
Mobilization/Demobilization	1	LS	$20,000	$20,000	
Surface Clearance	1	LS	$282,800	$282,800	
Demolition	1	LS	$5,600	$5,600	
Disposal	1	LS	$2,700	$2,700	
Report	1	LS	$16,000	$16,000	
SUBTOTAL (MEC Surface Clearance)				$352,100	
SUBTOTAL (All Activities)				$424,800	
Contingency (% of Sum)	10%			$42,480	
Project Management (% of Sum + Cont.)	5%			$23,364	
Construction Management (% of Sum + Cont.)	3%			$13,568	Excludes Statement of Basis
Total Capital Cost				**$504,212**	

Table A-2: Grenade Launcher Range
Alternative 2: Land Use Controls and MEC Surface Clearance

Annual Costs					
Description	**Quantity**	**Units**	**Unit Cost**	**Total Cost**	**Notes/Assumptions**
Fence and Sign Maintenance	1	LS	$1,834	$1,834	Replace missing and/or repair damaged fence and signs annually for 30 years
LUC Status Report	1	LS	$1,500	$1,500	Annual Report for GAEPD
SUBTOTAL				$3,334	
Contingency (% of Sum)	10%			$333	
Project Management (% of Sum + Cont.)	5%			$183	
Total Annual Cost				**$3,851**	

Periodic Costs						
Description	**Year**	**Quantity**	**Units**	**Unit Cost**	**Total Cost**	**Notes/Assumptions**
Periodic Review Reports	See note	1	LS	$55,000	$55,000	Preparation of report at end of years 5, 10, 15, 20, 25, and 30
SUBTOTAL					$55,000	
Contingency (% of Sum)		12%			$6,600	
Project Management (% of Sum + Cont.)		8%			$4,928	
Total Periodic Costs					**$66,528**	

Present Value Analysis					
Cost Type	**Year**	**Total Cost**	**Total Cost Per Year**	**Discount Factor (7%)**	**Present Value**
Capital	0	$504,212	$504,212	1.000	$504,212
Annual	1-30	$115,523	$3,851	12.409	$47,784
Periodic	5	$66,528	$66,528	0.713	$47,434
Periodic	10	$66,528	$66,528	0.508	$33,819
Periodic	15	$66,528	$66,528	0.362	$24,113
Periodic	20	$66,528	$66,528	0.258	$17,192
Periodic	25	$66,528	$66,528	0.184	$12,258
Periodic	30	$66,528	$66,528	0.131	$8,740
Total Present Value of Alternative					**$695,552**

Table A-3: Grenade Launcher Range
Alternative 3: MEC Surface and Subsurface Clearance

Capital Costs					
Description	**Quantity**	**Units**	**Unit Cost**	**Total Cost**	**Notes/Assumptions**
Statement of Basis					
Statement of Basis and Response to Comments	1	LS	$15,000	$15,000	Includes Public Review and Meeting
SUBTOTAL (Statement of Basis)				$15,000	
MEC Surface Clearance and Subsurface Clearance					
Planning Documents	1	LS	$48,000	$48,000	Explosive Safety Submission, Work Plan, Accident Prevention Plan
Mobilization/Demobilization	1	LS	$26,000	$26,000	Personnel and equipment
Brush Clearing	1	LS	$22,000	$22,000	
Surface Clearance	1	LS	$282,800	$282,800	
DGM	1	LS	$165,400	$165,400	
Intrusive Investigation	1	LS	$374,000	$374,000	
Demolition	1	LS	$10,000	$10,000	
Disposal	1	LS	$2,700	$2,700	
Completion Report	1	LS	$30,000	$30,000	
SUBTOTAL (MEC Subsurface Clearance)				$960,900	
SUBTOTAL				$975,900	
Contingency (% of Sum)	12%			$117,108	
Project Management (% of Sum + Cont.)	8%			$87,440.64	
Remedial Design (% of Sum + Cont.)	5%			$53,900.40	Excludes Statement of Basis
Construction Management (% of Sum + Cont.)	6%			$64,680.48	Excludes Statement of Basis
Total Capital Cost				**$1,299,030**	

Annual Costs
There are no annual costs associated with this Alternative following completion of MEC Clearance

Periodic Costs
There are no periodic costs associated with this Alternative following completion of MEC Clearance

Table A-3: Grenade Launcher Range
Alternative 3: MEC Surface and Subsurface Clearance

Present Value Analysis					
Cost Type	**Year**	**Total Cost**	**Total Cost Per Year**	**Discount Factor (7%)**	**Present Value**
Capital	0	$1,299,030	$1,299,030	1.000	$1,299,030
Annual	1-30	$0	$0	12.409	$0
Periodic	NA	$0	$0	NA	$0
Total Present Value of Alternative					**$1,299,030**