FINAL
FEASIBILITY STUDY SIEGE BATTERY – CONSTITUTION ISLAND MUNITIONS RESPONSE SITE WSTPT-015-R-02 U.S. ARMY GARRISON WEST POINT WEST POINT, NEW YORK

Prepared for:

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

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Alexandria, VA 22312

Contract No. W91DR-14-D-009
Task Order: 0005

July 2017

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ACRONYMS AND ABBREVIATIONS

°F	Degrees Fahrenheit
%	Percent
amsl	Above Mean Sea Level
ARAR	Applicable or Relevant and Appropriate Requirement
bgs	Below Ground Surface
BIP	Blow-in-Place
CDC	Contained Detonation Chamber
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CTT	Closed, Transferred, and Transferring
DDESB	Department of Defense Explosives Safety Board
DER	Division of Environmental Remediation
DERP	Defense Environmental Restoration Program
DGM	Digital Geophysical Mapping
DGPS	Differential Global Positioning System
DMM	Discarded Military Munitions
DoD	Department of Defense
EM	Engineering Manual
EMI	Electromagnetic Induction
EOD	Explosive Ordnance Disposal
EPA	Environment Protection Agency
ESA	Endangered Species Act
ESS	Explosives Safety Submission
FDEMI	Frequency-Domain Electromagnetic Induction
FS	Feasibility Study
gpm	Gallons per Minute
GPR	Ground Penetrating Radar
GPS	Global Positioning System
IA	Institutional Analysis
LIDAR	Light Detecting and Ranging
LUC	Land Use Control
LTM	Long-Term Management
m	Meter
MC	Munitions Constituents
MD	Munitions Debris
MEC	Munitions and Explosives of Concern
MEC HA	Interim Munitions and Explosives of Concern Hazard Assessment Methodology
mm	Millimeter
MMRP	Military Munitions Response Program
MPPEH	Material Potentially Presenting an Explosive Hazard
MRS	Munitions Response Site
MSD	Minimum Separation Distance
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NEW	Net Explosive Weight
NTCRA LUCP	Non-Time Critical Removal Action Land Use Control Plan
NYCRR	New York Codes, Rules, and Regulations
NYNHP	New York Natural Heritage Program

ACRONYMS AND ABBREVIATIONS (Continued)

NYSDEC	New York State Department of Environmental Conservation
O&M	Operation and Maintenance
PARS	PARS Environmental, Inc.
Plexus	Plexus Scientific Corporation
Plexus/PARS	Plexus/PARS Joint Venture
PPE	Personal Protective Equipment
PRG	Preliminary Remediation Goal
QA/QC	Quality Assurance/Quality Control
RAO	Remedial action objective
RI	Remedial Investigation
RWE	Revolutionary War Encampment
SAM	Sub Audio Magnetics
SAR	Synthetic Aperture Radar
SI	Site Inspection
SOP	Standard Operating Procedure
SPDES	State Pollutant Discharge Elimination System
SUXOS	Senior UXO Supervisor
RTS	Robotic Total Station
TAL	Target Analyte List
TBC	To-Be-Considered
TBD	To-Be-Determined
TCL	Target Compound List
TDEMI	Time-Domain Electromagnetic Induction
TMV	Toxicity, Mobility, or Volume
TP	Technical Paper
U.S.	United States
USACE	United States Army Corps of Engineers
USMA	U.S. Military Academy
UU/UE	Unlimited Use/Unrestricted Exposure
UXO	Unexploded Ordnance
UXOSO	UXO Safety Officer
UXOTII	UXO Technician II
UXOTIII	UXO Technician III
West Point	U.S. Army Garrison West Point
Weston	Weston Solutions, Inc.

1.0 INTRODUCTION

The United States Army Corps of Engineers (USACE) Baltimore District contracted with the Plexus Scientific Corporation (Plexus)/PARS Environmental, Inc. (PARS) Joint Venture (Plexus/PARS) to complete a Feasibility Study (FS) for the Siege Battery – Constitution Island (WSTPT-015-R-02) Munitions Response Site (MRS) at the United States (U.S.) Army Garrison West Point (West Point). The FS is being performed under Contract W91DR-14-D-009, Delivery Order 0005.

The Siege Battery – Constitution Island MRS (WSTPT-015-R-02) was investigated as part of the original Siege Battery MRS (WSTPT-015-R-01) during the Site Inspection (SI) and Remedial Investigation (RI) conducted in 2006 and 2011, respectively. As a result of the RI, the original Siege Battery MRS (WSTPT-015-R-01) was subdivided into three separate MRSs: the Siege Battery MRS (WSTPT-015-R-01), the Artillery Firing Range North MRS (WSTPT-001-R-02), and the Siege Battery – Constitution Island (WSTPT-015-R-02). The Siege Battery – Constitution Island MRS (WSTPT-015-R-02) is the focus of this FS and is included in the Defense Environmental Restoration Program (DERP) Military Munitions Response Program (MMRP). This FS is developed under the MMRP to address munitions and explosives of concern (MEC) potentially present at the MRS (i.e., Siege Battery – Constitution Island).

The RI and FS processes were developed in response to the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986. This FS has been prepared to be consistent with the National Oil and Hazardous Substances Pollution Contingency Plan (NCP); the *Final United States Army Military Munitions Response Program Munitions Response Remedial Investigation / Feasibility Study Guidance* (U.S. Army, 2009); and the *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (EPA, 1988).

1.1 Investigation History and Purpose

In 2003, the U.S. Congress established the MMRP under the DERP to address MEC and munitions constituents (MC) located on current and former defense sites. Properties classified as operational military ranges are not eligible for the MMRP. The DERP, including the MMRP, typically follows CERCLA and the NCP. The U.S. Army conducted an inventory of closed, transferred, and transferring (CTT) military ranges and defense sites (also known as the Phase 3 CTT), which meets the requirements of a CERCLA Preliminary Assessment. In this Phase 3 CTT at West Point, 10 closed ranges and two transferred areas with the potential for MEC, were identified as eligible for action under the MMRP. The Phase 3 CTT Range Inventory Report for West Point, which was completed in August 2004, included the original Siege Battery MRS (Weston Solutions, Inc.[Weston], 2015).

The next phase of the CERCLA process, the SI, was conducted at the original Siege Battery MRS in Spring 2006. The SI consisted of approximately 40 linear miles of visual surveys and the

collection of one sediment sample and seven surface soil samples. The visual surveys recovered one UXO item (3-inch Stokes mortar) and 17 MD items located on the Constitution Island portion of the original Siege Battery MRS. The sediment and soil samples were analyzed for the Target Compound List (TCL) explosives by Method 8330 and a subset of the Target Analyte List (TAL) metals by Methods SW846 6010B and 7471A. The following seven TAL metals: antimony, copper, iron, lead, mercury, potassium, and zinc, were selected for analysis based on the munitions historically used by West Point. The sediment and soil sampling results were compared (for evaluation purposes only) to the residential soil EPA Region 9 preliminary remediation goals (PRGs), when available. This comparison was made because background data were not available for the West Point area. MC (seven TAL metals: antimony, copper, iron, lead, mercury, potassium, and zinc, and TCL explosives) were not detected above EPA Region 9 PRGs for residential soil with the exception of iron. Iron was detected above the EPA Region 9 PRG for residential soil in two samples; however, the iron was determined to be naturally occurring based on the geology of the area. Because MEC (UXO: 3-inch Stokes mortar) was recovered, the SI recommended further evaluation of the original Siege Battery MRS for MEC and MC during the RI phase of the CERCLA process (Weston, 2015).

The RI was conducted between April and June 2011 to characterize the nature and extent of MEC and MC on the ground surface and in the subsurface of the original Siege Battery MRS. The RI determined that MC pathways were incomplete for the original Siege Battery MRS, based on incremental sampling that was performed. The RI did not identify any MEC but recovered 24 MD items on the Constitution Island portion of the original Siege Battery MRS. Because MEC was recovered during the SI and MD was recovered during the RI on Constitution Island, the RI recommended that the MRS undergo an FS (Weston, 2015).

The purpose of the FS is to identify, develop, and perform a detailed analysis of potential remedial alternatives that would meet the remedial action objectives (RAOs), and afford decision-makers adequate information to select the most appropriate remedial alternative(s). The selected alternative is expected to mitigate, reduce, or eliminate the explosive hazards posed to human receptors by MEC, based on the current and intended future use of the property.

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

- Identification of RAOs (Section 1).
- Identification of Applicable or Relevant and Appropriate Requirements (ARARs) and To-Be-Considered (TBC) guidance (Section 2).
- Identification of general response actions (Section 3).
- Identification and screening of potentially applicable remedial technologies and process options for the general response actions (Section 3).
- Development and screening of a range of remedial alternatives for the MRS based on combinations of the remedial technologies that were retained (Section 4).

- Performance of a detailed analysis for each of the remedial alternatives using the evaluation criteria as required by the NCP (Section 5).
- Performance of a comparative analysis of the remedial alternatives using the evaluation criteria as required by the NCP (Section 5).

1.2 West Point and Siege Battery – Constitution Island Munitions Response Site Description and History

West Point is located in Orange and Putnam Counties, New York, on the Hudson River (**Figure 1-1**). West Point is approximately 50 miles north of New York City and approximately 13 miles south of Newburgh. In its entirety, West Point encompasses 15,974 acres that are designated as three areas, the Main Post, the Military Reservation, and Constitution Island. The Main Post includes the majority of the academic, residential, and support facilities. The Military Reservation is largely undeveloped and contains operational training facilities, including firing ranges and bivouac areas used during the summer to house and train cadets. Constitution Island is located across the Hudson River from the Main Post, and is undeveloped and heavily forested. The MRS is located on Constitution Island within Putnam County on land owned and managed by the U.S. Army (**Figure 1-2**). The MRS is bound to the north, west, and south by the Siege Battery – TD River MRS (WSTPT-016-R-01). The eastern side of the MRS is bound by undeveloped land, areas of cultural significance, and the Seacoast Battery MRS (WSTPT-013-R-01). The MRS contains the Revolutionary War Encampment and a historic redoubt (Redoubt No. 7). The layout of the MRS is presented in **Figure 1-3**.

The MRS was created from the portion of the Siege Battery firing range fan that overlays Constitution Island. The MRS also includes the land portion of the Seacoast Battery firing range fan that was not included in the Seacoast Battery MRS (WSTPT-013-R-01). The firing range fans represent areas where munitions fired from the Seacoast Battery and the Siege Battery may have landed. The MRS would have received fire from the Seacoast Battery and/or the Siege Battery that were firing at targets in the Hudson River or other locations. The MRS was not a target area. The firing range fans that comprise the MRS are presented in **Figure 1-4**. The eastern side of the Siege Battery firing range fan was reduced because West Point indicated that the Village of Cold Spring had been there "for a long time;" therefore, no firing would have occurred over or into the Village of Cold Spring (TLI, 2006). The munitions-related history of the Seacoast Battery was presented in a separate FS (Plexus, 2017). The munitions-related history of the Siege Battery is presented below.

The Siege Battery was constructed in approximately 1845 on the site of Battery Sherburne, at what is now called Trophy Point. Battery Sherburne was built in 1778 and contained two iron six-pounders on garrison carriages and eight iron six-pounders on stocked or field carriages. Six-pounders fired solid metal artillery munitions that did not contain any explosive material. Construction of the Siege Battery is believed to have destroyed all traces of Battery Sherburne. A photograph of the Siege Battery taken in 1869 depicts a variety of 20- and 30-pounder Parrott

rifles, and various mortars. During the latter part of the 19th century, the Siege Battery was renamed Battery Schofield and was used for training with Parrott rifles. Between 1876 and 1889, several guns burst at the Siege Battery, including a 4.5-inch rifled gun and two 30-pounder Parrott guns. The battery of 30-pounder Parrott guns was condemned in 1889, and was then replaced by a battery of old 4.5-inch rifled guns (Weston, 2015).

In 1891, the armament of the Siege Battery consisted of six 4.5-inch rifled cast-iron siege guns, three 10-inch smooth bore siege mortars, and three 8-inch smooth bore siege mortars. In 1892, the three 8-inch mortars were removed and replaced with three 10-inch smooth bore mortars. Additionally, six 3.2-inch rifles were mounted on the wooden carriages of the 3-inch rifles and used for drill practice. Although the 4.5-inch guns remained in position, their replacement with four new 5-inch steel breech-loading guns and two 7-inch steel breech-loading howitzers had begun. By 1898, two 5-inch breech-loading siege rifles were in use (Weston, 2015).

A complete new Siege Battery, consisting of four 5-inch breech-loading rifles and two 7-inch breech-loading howitzers, a complete battery of six 7-inch steel breech-loading mortars, and two 3.2-inch guns, was received in 1899. All of the weapons were in use by 1906. The target for the guns used at the Siege Battery was on Crows Nest mountain, an approximate 2,000-yard distance. Full charges were not used in any of the guns. The targets for the mortars were anchored in the Hudson River. Heavy ordnance at the battery could not be fired with full-service charges because of the close range of the targets (Weston, 2015).

Use of the Siege Battery ended between 1906 and 1910, when Battery Schofield came into service. During the fall and spring of 1907-08, an additional battery of two 6-inch disappearing coastal defense guns was constructed immediately in front and just north of the Siege Battery. Battery Schofield had no magazine or shell rooms, but instead had a 16-foot by 12-foot storeroom between the guns. These 6-inch guns were used for sub-caliber practice, using a floating target towed back and forth across the Hudson River between Storm King Mountain on the west side of the Hudson River and Cold Spring, which is on the east bank of the Hudson River. Practice from the battery occurred in April and October, but full charges were not used in any of the guns (Weston, 2015).

1.3 Summary of Remedial Investigation Results

This section provides a summary of the environmental setting and the results of the RI conducted at the MRS, including the nature, extent, and hazards associated with MEC. The RI determined that an explosive safety hazard is present at the MRS. In addition, the RI determined that MC pathways to potential receptors (human and ecological) were incomplete because no MC source was identified. The environmental setting and results are discussed in greater detail in the RI (Weston, 2015).

1.3.1 Environmental Setting

1.3.1.1 Climate

The climate of the region is characterized as a humid, continental one. Affected by the semi-permanent Bermuda High, which brings south to southwest warm and humid air, summers are warm with periods of high humidity. July is the hottest month with a mean temperature of 86 degrees Fahrenheit (ºF); January is the coldest month with a mean temperature of 27 ºF. Winters are cold with extended periods of snow accumulation and are influenced by the cold Hudson Bay air masses. Most winters are characterized by one or more warm periods when soil nearly or completely thaws. A third weather pattern that influences the climate of West Point is an air mass that flows inland from the North Atlantic Ocean, bringing cool, cloudy, and damp weather to the region. Prevailing winds are generally westerly (Weston, 2015).

Thunderstorms occur approximately 20 times per year. Tornadoes occur at a frequency of three to four times a year in the region, although no significant tornadoes have occurred at West Point for more than 20 years. Total annual precipitation is greater than 49.5 inches, with monthly precipitation ranging from approximately 3.5 inches (January/February) to approximately 4.9 inches (May) (Weston, 2015).

1.3.1.2 Geology

West Point lies in the Hudson Highlands, a low, rugged mountain range with a zone of metamorphic and igneous rock formations subjected to extensive weathering and erosion. The bedrock geology of the area is leucogranitic gneiss, rusty and gray biotite-quartz-feldspar gneisses, biotite-quartz-plagioclase gneiss, hornblende granite and granitic gneiss, and quartz plagioclase gneiss (Weston, 2015).

Precambrian-age granite, diorite, gneiss, and schist form the major crystalline bedrock underlying the MRS. Igneous rocks on the West Point installation consist of plagioclase feldspar, hornblende, pyroxene, and biotite mica and quartz. The metamorphic rocks exist in sequences composed of a hard layer of banded rock and gneiss, which is sometimes intruded by igneous rocks. Marble, quartzite, schist, and amphibolite are other types of metamorphic rocks present in the Highlands area. During the Precambrian period, these sediments and rocks were possibly subjected to extensive regional metamorphism, partial melting, and magmatic intrusion. The Cantonment area bounded by the Hudson River is underlain by exposed bedrock and glacial alluvium (Weston, 2015).

The faults mapped at the surface near and within the habitation area at West Point include Long Pond, Crown Ridge, and Highland Brook. The Long Pond fault trends northeast-southwest along the northwestern boundary of the habitation area and the Storm King Highway (New York Route 218). The Crown Ridge fault also trends northeast-southwest and extends through Lusk Reservoir. The Highland Brook fault trends northwest-southeast along Route 9W and the Storm King Highway between the Long Pond and Crown Ridge faults (Weston, 2015).

The surficial geologic formations on the West Point installation are outcroppings, talus, and glacial deposits. During glacier retreat, features were formed along the valley walls, the most prominent one being the Kame terraces. In all but the flat, marshy areas, bedrock can be observed. A thin veneer layer of Pleistocene-age glacial deposits, both stratified and unstratified, overlies the igneous and metamorphic bedrock sequence. The stratified drift consists primarily of sand and gravel deposited in glacial lakes and streams; the unstratified drift consists of glacial till material, which is mainly large boulders and clay, sand, and gravel deposited directly from glacial ice as it progressed or regressed across the area. Site-specific geologic investigations were not conducted at the MRS. Regional geologic maps indicate that the bedrock geology of the MRS includes, rusty and gray biotite-quartz-feldspar gneiss, leucogranitic gneiss, biotite-quartz-plagioclase gneiss, and quartz plagioclase gneiss (Weston, 2015).

1.3.1.3 Topography

The topography of West Point is described as having moderately steep hills and numerous escarpments. Slopes from 10 to 60 percent (%) are common on the installation. Areas in between the hills are interspersed with small plains, basins, and narrow valleys with slopes less than 3%. The topography of the surrounding region is undulating and rugged. These characteristics, along with the alluvium and till deposits in the lowland areas and the relatively flat valley bottoms of the region, are the result of glaciation (Weston, 2015). The MRS includes steep terrain and ranges in elevation from mean sea level to 100 feet above mean sea level (amsl). The shoreline along the Hudson River in the southern portion of the MRS includes steep cliffs ranging in elevation from mean sea level to 20 feet amsl. The topography of the MRS is presented in **Figure 1-3**.

1.3.1.4 Soil

The MRS consists of two soil types: the Chenango and the Charlton-Paxton. The Chenango soils (gravelly, silt loam) are the primary soil type, and range in slope from 3% to 15%. The Charlton-Paxton soils (extremely stony, sloping) comprise the remainder of the MRS. The Chenango soils are formed from water sorted material on alluvial fans and are well drained to excessively well drained with depth to bedrock exceeding 60 inches. The Charlton-Paxton soils are formed in loamy melt-out till on ridges or steep cliffs and are well drained with depth to bedrock exceeding 60 inches. The soils at West Point appear to be naturally high in iron because of the oxidized iron content of the underlying geologic formation (TLI, 2007).

1.3.1.5 Hydrogeology

1.3.1.5.1 Surface Water

Although no surface water resources exist within the MRS, the MRS is bound by the Hudson River to the north, west, and south. Constitution Island does not contain any surface water bodies; however, an approximately 19-acre freshwater emergent wetland is located approximately 500 feet from the northeastern corner of the MRS (**Figure 1-3**).

1.3.1.5.2 Groundwater

Groundwater on West Point occurs in an unconsolidated aquifer consisting of alluvial deposits and a consolidated bedrock aquifer. Water within the unconsolidated aquifer occurs primarily in the sands and gravels of the stratified drift deposits. These deposits represent the most prolific sources of groundwater on the installation, but the deposits are thin and generally have fairly small well yields that average about 40 gallons per minute (gpm). Water in the unconsolidated aquifer usually occurs under water table conditions. Recharge to the aquifer is primarily from local precipitation, but hydrologic communication occurs between the alluvial and the bedrock aquifers, and some upward seepage from the bedrock aquifer occurs in low-lying areas. Site-specific groundwater investigations were not conducted for the MRS (Weston, 2015).

1.3.1.6 Ecology

West Point lies in New York State, bordering the west bank of the Hudson River in the lower Hudson River Valley. Its environmental setting is unique as the five physiographic provinces (i.e., the Appalachian Plateaus, Folded Appalachians [Valley and Ridge], New England, Piedmont, and Coastal Plain) converge within a 35-mile radius of the West Point installation. West Point is located in the New England Province in an area known as the Hudson Highlands (Weston, 2015).

1.3.1.6.1 Special Natural Areas

West Point has identified 12 sites that are to be specially managed because of ecological or geological significance, unique geological structure, and/or aesthetic and educational value to the installation. Constitution Island is one of the 12 specially managed sites, and the MRS occupies about one third of Constitution Island. The MRS contains the Revolutionary War Encampment (RWE) and a historic redoubt (Redoubt No. 7). The RWE and Redoubt No.7 provide educational value to the installation. Constitution Island is the highest (maximum elevation 140 feet) and largest (177 acres) of the Hudson River's rocky islands.

As described in the *Integrated Natural Resources Management Plan for the United States Army Garrison – West Point, 2011-2015*, Constitution Island supports a largely undisturbed matrix of forest, grassland, and wetlands. These ecological features provide aesthetic value to the installation. Forests cover most of the island. Crests support chestnut-oak forest, oak-pine woodland, or oak-heath rocky summit savanna; hollows support hemlock-hardwoods (primarily oaks); and lowlands support red maple swamp. Non-forest communities include patches of rocky summit grassland, steep riverfront cliffs, rocky intertidal shores, and areas frequently mowed or cleared of tall woody plants. The MRS primarily includes chestnut-oak forest and oak-pine woodland, but also includes steep river front cliffs (Tetra Tech, Inc., 2011). A 1993 wetland inventory conducted on all West Point properties identified eight wetland habitats on the island.

Contributing to its regional value, Constitution Island provides habitat for a number of sensitive fauna and flora species. The bald eagle (state threatened) is a frequent winter visitor, and least bitterns (state threatened), small-footed bat (state special concern), ospreys (state special concern),

and spotted turtles (state special concern) have been sighted. Rare and unusual plants found on the island include prickly pear cactus (*Opuntia sp.*), cluster sedge (*Carex cumulata*), weak stellate sedge (*Carex seorsa*), pigmy weed (*Crassula [Tillaea] aquatica*), slender crabgrass (*Digitaria filiformis*), yellow harlequin (*Corydalis flavula*), small-flowered crowfoot (*Ranunculus micranthus*), violet wood-sorrel (*Oxalis violacea*), two-flowered bladderwort (*Uticularia biflora*), green-fruited clearweed (*Pilea fontana*), red-root cyperus (*Cyperus erythrorhizos*), sedge (*Carex seorsa*), and Long's bittercress (*Cardimine longii*; Weston, 2015).

1.3.1.6.2 Wetlands

There are approximately 1,010 acres of wetlands located throughout West Point in association with streams, ponds, depressions, and seeps. There are four wetland areas totaling 2.24 acres located within the MRS (**Figure 1-3**). Three of the four wetlands are classified as palustrine scrub shrub wetlands and total 2.12 acres. The fourth, a 0.12 acre wetland, is a palustrine forested wetland.

1.3.1.6.3 Flora

The MRS is undisturbed and heavily forested.

1.3.1.6.4 Fauna

Forty-eight species of mammals, 249 species of birds, 22 species of reptiles, and 18 species of amphibians have been documented on West Point, in addition to many fish and invertebrate species. It is likely that some of these species would rely on the MRS for habitation since it is undeveloped (Weston, 2015).

1.3.1.6.5 Other Species of Potential Concern

The following list contains species that have the potential to exist within the MRS:

- Mammals: Small-footed bat and Indiana bat.
- Birds: Cooper's hawk, Northern goshawk, sharp-shinned hawk, golden eagle, American bittern, red-shouldered hawk, whip-poor-will, common nighthawk, cerulean warbler, Peregrine falcon, common loon, bald eagle, yellow-breasted chat, red-headed woodpecker, osprey, pied-billed grebe, vesper sparrow, and golden-winged warbler.
- Reptiles: Eastern wormsnake, wood turtle, timber rattlesnake, Eastern hognose, and Eastern box turtle.
- Insects, Dragonflies, and Damselflies: Needham's skimmer.
- S1* Plants: Virginia snakeroot, glomerate sedge, stripe-fruited sedge, and Carolina cranesbill.
- S2* Plants: Long's bittercress, midland sedge, slender crabgrass, violet wood sorrel, Carey's smartweed, and small-flowered crowfoot.

- S2S3* Plants: Cluster sedge, purple milkweed, Emmon's sedge, Bicknell's sedge, Bush's sedge, false hop sedge, weak stellate sedge, yellow harlequin, racemed pinweed, violet bush clover, slender knotweed, and gemmed bladderwort.

  *Notes:

  S1 = Critically imperiled in New York State because of extreme rarity (five or fewer sites or very few remaining individuals) or extremely vulnerable to extirpation from New York State due to biological or human factors.

  S2 = Imperiled in New York State because of rarity (6 to 20 sites or few remaining individuals) or highly vulnerable to extirpation from New York State due to biological or human factors.

  S3 = Rare in New York State (usually 21 to 35 extant sites).

  Double Ranks (i.e., S2S3) = The first rank indicates rarity based upon current documentation. The second rank indicates the probable rarity after all historical records and likely habitat have been checked.

An MRS-specific inventory of floral and faunal species was not conducted in the MRS. However, the *Integrated Natural Resources Management Plan for the United States Army Garrison – West Point, 2011-2015* contains an extensive list of species that were documented on Constitution Island. There is a potential for other species known to exist on Constitution Island to traverse and/or be present on the MRS because of the similar habitat types and proximity (Weston, 2015).

1.3.1.7 Sensitive Environmental Resources within the Munitions Response Site

The New York Natural Heritage Program (NYNHP) identified the following species with the potential to occur within the West Point MRSs: one mammal species (small-footed myotis [bat, *Myotis leibii*]), two species of birds (bald eagle [*Haliaeetus leucocephalus*] and least bittern [*Ixobrychus exilis*]), one reptile species (timber rattlesnake [*Crotalus horridus*]), three fish (shortnose sturgeon [*Acipenser brevirostrum*], Atlantic sturgeon [*Acipenser oxyrhynchus*], and Atlantic silverside [*Menidia menidia*]), and one insect (Needham's skimmer [*Libellula needhami*]).

With the exception of the three fish species and the least bittern, the remaining species have the potential to occur in the MRS. The NYNHP did not identify any federally threatened or endangered plant species in any of the West Point MRSs (Weston, 2015).

1.3.1.8 Cultural and Archaeological Resources

Because West Point is one of the older training grounds in the U.S. that is still intact, it contains numerous cultural, archaeological, and historical sites. Several sensitive and very well-preserved Revolutionary War sites are present along the shoreline of Constitution Island. The MRS contains two historic and culturally significant Revolutionary War sites in the southern portion of the MRS. These areas are the RWE and Redoubt No.7. The site of a former forge, "Smithy;" and a Revolutionary War parade grounds are also located nearby to the southeast of the MRS (Weston, 2014).

1.3.1.9 Current and Projected Land Use

Most of the land area on the Main Post is highly developed or is considered undevelopable because of the steep slopes. West Point is divided into six land use zones based on the functional categories that reflect the West Point missions:

- Cadet Use: Academic, intramural athletic, billeting, and parading.
- Cadet Support: Intercollegiate athletic fields and some cadet support facilities.
- Community Support Zone: Housing, commercial, and service support to staff and faculty, non-West Point military personnel, and military retirees.
- Recreational, Industrial, Field Training: Building and storage area support for industrial operation, field training areas, recreation areas, and open space.
- Candidate Zone: Encompasses the USMAPS and its supporting facilities.
- Strategic Outreach Zone: Specialized areas where land use and facilities are dedicated to the positive interaction between the institution of West Point and the public (West Point, 2016).

The MRS is located in the Recreational, Industrial, and Field Training land use zone and consists of open space used for recreational activities. The recreational activities are conducted only in the southern portion of the MRS where a trail, the RWE, and Redoubt No. 7 are located (**Figure 1-3**). The trail is maintained by the Constitution Island Caretaker and used by recreationists to visit the RWE and Redoubt No. 7 during guided walking tours of Constitution Island. The guided walking tours are offered during the summer months and arranged through the West Point Visitor Center. The recreational users are brought to Constitution Island by boat from West Point. Access to the MRS by land is restricted by a road with a locked gate that must be opened by contacting the Constitution Island Caretaker. There are currently no plans for the construction of additional trails; however, these activities may be conducted by contractor personnel in the future. While additional trails may be constructed in the future, the current and future land use zoning of the MRS is not expected to change.

1.3.2 Munitions and Explosives of Concern

The term MEC distinguishes specific categories of military munitions that may pose unique explosive safety risks that are present in high enough concentrations to pose an explosive hazard, which, include the following:

- **Unexploded Ordnance (UXO)**—Military munitions that fulfill the following criteria:
    - Have been primed, fuzed, armed, or otherwise prepared for action;
    - Have been fired, dropped, launched, projected, or placed in such a manner as to constitute a hazard to operations, installations, personnel, or material; and

- Remain unexploded either by malfunction, design, or any other cause (Department of Defense [DoD], 2008).

- **Discarded Military Munitions (DMM)**—Military munitions that have been abandoned without proper disposal or removed from storage in a military magazine or other storage area for the purpose of disposal. The term does not include UXO, military munitions that are being held for future use or planned disposal, or military munitions that have been properly disposed of consistent with applicable environmental laws and regulations (DoD, 2008; 10 USC 2710(e)(2)).

  MC—The definition of MEC also includes chemicals such as, trinitrotoluene and hexahydro-1,3,5-trinitro-1,3,5-triazine present in high enough concentrations to pose an explosive hazard.

  MC refers to any materials originating from MEC; discarded military munitions; or other military munitions, including explosive and nonexplosive materials, and emission, degradation, or breakdown elements of such munitions (10 USC 2710(e)(3)).

Although MD is not MEC, MD was investigated during the RI as evidence of potential MEC.

- **MD**—refers to any remnants of munitions (e.g., fragments, penetrators, projectiles, shell casings, links, fins) remaining after munitions use, demilitarization, or disposal (U.S. Army, 2009).

1.3.2.1 Nature and Extent of Munitions and Explosives of Concern

A mag and dig survey was performed at the MRS to delineate the nature and extent of MEC. The mag and dig survey consisted of four transects covering approximately 1.5 acres or 3% of the MRS. A total of 36 subsurface anomalies were detected during the mag and dig survey. No surface anomalies were detected during the RI.

The detected anomalies were intrusively investigated, and no MEC and 24 MD items were recovered. The MD items consisted of 24 fragments from unknown munitions. The locations of the MD items recovered during the RI are presented in **Figure 1-5**. The MD items recovered during the RI are presented in **Table 1-1**.

Table 1-1 Summary of Munitions and Explosives of Concern and Munitions Debris at the Siege Battery – Constitution Island Munitions Response Site

Item Type	Item Description	Dig Date	Depth (inches)	Weight (pounds)
UXO*	3-inch Stokes mortar	April/May 2006	Surface	NA
MD	24 fragments, unknown	06/29/2011	1 – 8	27

Notes:
MD Munitions Debris NA Not Available
* Only MEC discovered at the MRS was recovered during the SI. The recovered MEC item is composed of iron-containing or "ferrous" materials.

A total of 27 pounds of MD were recovered between one inch and eight inches bgs from the MRS on June 29, 2011 during the RI. As previously indicated, the only MEC (UXO: 3-inch Stokes mortar) was discovered on the ground surface during the SI. The MC sampling conducted during the SI indicated that MC was not present above regulatory standards or background. The collection of additional MC samples was not conducted during the RI because no MC source was identified; therefore, the RI determined that MC pathways to potential receptors (human and ecological) were incomplete.

1.3.2.2 Munitions and Explosives of Concern Fate and Transport

The following physical processes can transport and relocate an MEC from its original placement at the MRS:

- Picking up or moving a potential MEC by a human receptor;
- Disturbance of potential MEC during intrusive activities conducted by a human receptor; and
- Soil erosion and frost heave.

The natural processes of soil erosion and frost heave are capable of transporting and relocating an MEC from its original placement at the MRS. The erosion of soil caused by wind, gravity, or water (precipitation) may move MEC across the surface or move subsurface MEC to the surface. In addition to erosion, subsurface MEC may migrate to the surface during freezing and thawing cycles. The upward migration of MEC occurs when water below the MEC freezes and expands. This expansion gradually moves the subsurface MEC upward towards the surface. This phenomenon, known as "frost heave," predominantly affects subsurface MEC located above the frost line. The frost heave susceptibility of any given soil is influenced by its hydraulic characteristics (i.e., well drained or poorly drained; Chamberlain, 1981). The well drained to excessively well drained soil types (Chenango and Charlton-Paxton) present at the MRS are not typically susceptible to frost heave. Therefore, the soil type within the MRS indicates the transport of potential subsurface MEC to the surface caused by frost heave would be minimal.

1.3.2.3 Revised Munitions and Explosives of Concern Conceptual Site Model

This section presents the revised MEC conceptual site model (CSM) for the MRS. The MEC CSM revision was based on additional information provided by West Point in 2016. An MC CSM revision is not warranted because the RI determined that MC pathways to potential receptors (human and ecological) were incomplete.

1.3.2.3.1 Revised Munitions and Explosives of Concern Exposure Pathway Analysis

The MEC exposure pathway analyses for the MRS are summarized in this section. The pathway analyses consist of a source, receptor, and interaction component, and also identify whether the pathway is complete, potentially complete, or incomplete. A pathway is considered complete when

a source (MEC) is known to exist, and when receptors have access to the MRS while engaging in an activity that may result in contact with the source. A pathway is considered potentially complete when a source (MEC) has not been confirmed, but is suspected to exist (i.e., MD was recovered), and when receptors have access to the MRS while engaging in an activity that may result in contact with the source. A pathway is considered incomplete if any one of the three components (source, interaction, or receptors) is not present at the MRS.

1.3.2.3.1.1 Source

An MEC source was confirmed on the surface because MEC was recovered from the surface at the MRS. An MEC source is suspected to exist within the subsurface because only MD was recovered from the subsurface at the MRS. The results of the RI, including the MEC recovered during the SI, are presented in Section 1.3.2.1 and summarized in **Table 1-1**, and depicted in **Figure 1-5**.

1.3.2.3.1.2 Receptors and Interaction

The human receptors that are likely to have access to the MRS and the activities in which those human receptors engage were identified by West Point in 2016. These human receptors and the activities that they may conduct are summarized below:

- The Constitution Island Caretaker may contact MEC potentially located on the surface while conducting trail maintenance (i.e., grass cutting) in the southern portion of the MRS.
- Recreational users may contact MEC potentially located on the surface while walking the trail or visiting the RWE and Redoubt No. 7 located in the southern portion of the MRS.
- Contractor personnel may contact MEC potentially located on the surface by walking in the MRS during future construction. Contractor personnel may also contact MEC potentially located within the subsurface when conducting intrusive activities during future trail construction. It should be noted that there are currently no plans for the construction of a future trail.

1.3.2.3.1.3 Conclusions

The results of previous investigations and additional information provided by West Point was utilized to revise the MEC CSM for the MRS, and to identify complete, potentially complete, or incomplete exposure pathways for current and future land use. The previous investigations identified a surface MEC and multiple subsurface MD items associated with the historical activities conducted at the MRS. The presence of MEC on the surface indicates that the surface exposure pathway is complete because human receptors (e.g., the Constitution Island Caretaker, recreational users, and contractor personnel) have access to the surface of the MRS. The presence of MD within the subsurface indicates that the subsurface exposure pathway is potentially complete because human receptors (e.g., contractor personnel) may conduct intrusive activities within the MRS. The revised MEC CSM for the MRS is presented in **Figure 1-6**.

1.3.2.4 Munitions and Explosives of Concern Hazard Assessment

In October 2008, the Technical Working Group for Hazard Assessment, which included representatives from the DoD, Department of the Interior, EPA, and other officials, made available the technical reference document, *Interim Munitions and Explosives of Concern Hazard Assessment Methodology*. This document is designed to be used as the CERCLA hazard assessment methodology for MRSs where there is an explosive hazard from the known or suspected presence of MEC. The MEC Hazard Assessment (MEC HA) was used to assess the explosives hazards for the MRS. The MEC HA includes evaluation of three components of a potential explosive hazard incident:

Severity—The potential consequences (e.g., death, severe injury, property damage) of MEC detonating.

Accessibility—The likelihood that a receptor will be able to come in contact with MEC.

Sensitivity—The likelihood that a receptor will be able to interact with MEC so that it will detonate.

Each of these components is assessed in the MEC HA by determining input factor scores for an MRS. The sum of the input factor scores falls within one of four defined ranges, called hazard levels. Each of the four levels reflects MRS attributes that describe groups of MRSs and MRS conditions ranging from the highest to the lowest hazards. The MEC HA hazard levels include:

Hazard Level 1—MRSs with the highest hazard potential. There may be instances where an imminent threat to human health exists from MEC.

Hazard Level 2—MRSs with a high hazard potential. An MRS with surface MEC or one undergoing intrusive activities so that MEC would be encountered in the subsurface. The MRS would also have moderate or greater accessibility by the public.

Hazard Level 3—MRSs with a moderate hazard potential. An MRS that would be considered safe for the current land use without further munitions response, although not necessarily suitable for reasonable, anticipated future use. Hazard Level 3 MRSs generally would have restricted access, a low number of contact hours, and typically MEC only in the subsurface.

Hazard Level 4—MRSs with a low hazard potential. An MRS compatible with current and reasonably anticipated future use. Hazard Level 4 MRSs typically have had an MEC cleanup performed.

The MEC HA fits into MMRP activities and the regulatory structure of CERCLA by addressing the NCP Code of Federal Regulations (CFR) 300.430(d)(4) requirement to conduct site-specific risk assessments for threats to human health and the environment; however, the MEC HA does not directly address environmental or ecological concerns that may be associated with MEC (EPA, 2008).

The 2008 MEC HA guidance document includes an automated workbook that develops site scoring through standardized inputs and formulas. As part of the RI, the automated workbook was used to provide a MEC HA Hazard Score for the MRS. The results of the MEC HA for the MRS are presented below.

Site: Siege Battery – Constitution Island MRS	Hazard Level	Hazard Score
Current Use Activities	3	690

For current and future use activities, the MRS has a Hazard Level of 3, which indicates the MRS has a moderate potential explosive hazard condition. The discovery of MEC at the MRS means that an explosive hazard may exist. The inputs used for the MEC HA of the MRS are presented in **Appendix A**.

1.4 Remedial Action Objectives

The NCP, CFR 300.430(e)(2)(i) specifies that RAOs be developed to address:

(1) Contaminants of concern;

(2) Media of concern;

(3) Potential exposure pathways; and

(4) PRGs.

RAOs are defined to determine the effectiveness of the remedial actions, developed for MEC based on the MRS requirements and exposure pathways, and focused on limiting or removing exposure pathways for MEC (U.S. Army, 2009). The USACE Engineering Manual (EM) 200-1-12 states: "Although humans are typically considered as the primary and often the only receptor to MEC, the presence of ecological or cultural resources on an MRS should be known to avoid or mitigate response actions (e.g., vegetation removal) that could adversely impact such resources." The 2008 EPA MEC HA guidance recommends that the presence of ecological resources be addressed during the CERCLA nine criteria analysis. Furthermore, this guidance defines ecological resources for the purposes of the MEC HA as including the following:

1. A threatened or endangered species, designated under the Endangered Species Act (ESA), is present on the MRS;
2. An MRS designated under the ESA as a critical habitat for a threatened or endangered species; or
3. Identified sensitive ecosystems such as wetlands or breeding grounds present on the MRS.

The RI identified ecological resources (e.g., wetlands) and cultural resources (e.g., RWE and Redoubt No. 7) at the MRS. The adverse impacts to ecological and cultural resources resulting from a response action will be addressed during the screening and detailed analysis of alternatives.

The RAOs for the MRS will address the overall goal of protecting human receptors from the explosive hazards posed by MEC. The following human receptors were identified for the MRS: the Constitution Island Caretaker, recreational users, and contractor personnel. The Constitution Island Caretaker, recreational users, and contractor personnel may contact MEC potentially located on the surface by walking. The contractor personnel may contact MEC potentially located in the subsurface by conducting intrusive activities.

The following RAOs were developed for the MRS because complete and potentially complete exposure pathways are present:

- Reduce or eliminate direct contact of the Constitution Island Caretaker, recreational users, and contractor personnel with the potential explosive hazards posed by MEC present on the surface.
- Reduce or eliminate direct contact of contractor personnel with the potential explosive hazards posed by MEC potentially located within subsurface soil.

This FS assembles general response actions and technologies/technology process options into alternatives that satisfy these RAOs.

2.0 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS AND TO-BE-CONSIDERED GUIDANCE

ARARs are identified on a site-specific basis using a two-part analysis: (1) determining whether a given requirement is applicable; then, if it is not applicable, (2) determining whether a requirement is both relevant and appropriate. To determine whether a requirement is relevant and appropriate, characteristics of the remedial action, the hazardous substances present, and the physical characteristics of the site must be compared to those addressed in the statutory or regulatory requirement. In some cases, a requirement may be relevant, but not appropriate, given site-specific circumstances; such requirements would not be an ARAR for the site. In other cases, only part of a requirement may be considered relevant and appropriate. When it is determined that a requirement is both relevant and appropriate, the requirement must be complied with (or waived) to the same degree as if it were applicable (EPA, 1988).

As defined in the NCP, "Applicable Requirements" are cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental, state environmental, or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Only those state standards that are identified by a state in a timely manner and that are more stringent than federal requirements may be applicable (40 CFR 300.5).

"Relevant and Appropriate Requirements" are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site. Only those state standards that are identified by a state in a timely manner and that are more stringent than federal requirements may be applicable (40 CFR 300.5).

Section 121(d) of CERCLA requires that remedial actions be evaluated to determine if they meet any standard requirement, criteria, or limitation under any federal environmental law; any promulgated standard, requirement, criteria, or limitation under a state environmental or facility siting law that is more stringent than any federal standard, requirement, criteria, or limitation; and any standard, criteria, or limitation that is determined to be an ARAR. The NCP requires compliance with ARARs during and upon completion of remedial actions. Under limited circumstances, ARARs for on-site remedial actions may be waived.

There are three types of ARARs: location-specific, action-specific, and chemical-specific.

Chemical-specific ARARs—usually health- or risk-based numerical values, which, when applied to site-specific conditions, result in the establishment of an acceptable amount or concentration of a chemical that may be found in or discharged to the ambient environment. Preliminary chemical-

specific ARARs are typically identified in the RI to provide benchmarks with which to compare environmental sampling results for metals and explosives.

Location-specific ARARs—generally restrictions may be placed on the types of activities that may occur in particular locations. Location-specific ARARs generally prevent damage to unique or sensitive areas, such as flood plains, historic places, wetlands, and fragile ecosystems, and restrict other activities that are potentially harmful because of where they take place.

Action-specific ARARs—usually technology- or activity-based requirements or limitations placed on actions taken with respect to cleanup actions, or requirements to conduct certain actions to address particular circumstances at a site. Set performance, design, or other similar operational controls or restrictions on particular activities related to management of hazardous substances or pollutants. These requirements address specific activities that are used to accomplish a remedy. Action-specific ARARs do not in themselves determine the remedial action; rather, they define how a selected remedial action alternative must be designed, operated, or managed.

CERCLA and the NCP also recognize the TBC category, which includes non-promulgated advisories or guidance issued by Federal or State government that are not legally binding and do not have the status of potential ARARs. However, TBCs are considered along with ARARs as part of the site risk assessment and may be used in determining the necessary level of cleanup for protection on health or the environment. When this is the case, at the discretion of the lead agency, they can be specified as TBC criteria. TBC criteria can be taken into consideration during evaluation of remedial alternatives but, unlike ARARs, identification of TBCs is not mandatory nor is compliance with TBCs a selection criterion for a remedial action.

TBC—non-promulgated policies, criteria, advisories, guidance, and proposed standards developed by Federal and State environmental and public health agencies that are not legally enforceable but contain helpful information are collectively referred to as TBC criteria. They can be helpful in carrying out selected remedies or in determining the level of protectiveness of selected remedies. The TBCs are meant to complement the use of ARARs, not compete with or replace them.

Preliminary ARARs were identified and documented in the RI. Preliminary chemical-specific ARARs were not identified for the MRS because field investigation activities did not detect MC in excess of screening criteria. Preliminary location-specific ARARs also were not identified for the MRS because the results of the RI indicated that the potential alternatives would not include activities that would affect ecological resources located in the MRS. However, preliminary action-specific ARARs were identified for the MRS. The preliminary action-specific ARARs were based on the development of alternatives which would not include on-site treatment, on-site storage (greater than 90 days), or on-site disposal of hazardous waste (Weston, 2015).

The preliminary action-specific ARARs were evaluated for applicability and appropriateness and relevance. The preliminary action-specific ARARs that were determined to be either applicable or relevant and appropriate for the MRS are summarized in **Table 2-1**.

Table 2-1 Applicable or Relevant and Appropriate Requirements

Standard, Requirement, Criteria, or Limitation	Citation	Description of Requirement	Comments (Applicable or Relevant and Appropriate)
Resource Conservation and Recovery Act, Subpart X, Miscellaneous Units	40 CFR Part 264, Subpart X, Section 264.601 (Environmental Performance Standards)	Miscellaneous units used for the disposal of munitions must be located, designed, constructed, operated, maintained, and closed in a manner that will ensure protection of human health and the environment.	*Relevant and Appropriate* Subpart X is a promulgated standard but is not applicable because the Army is not an owner of a facility that will treat, store, or dispose of hazardous waste in a miscellaneous unit. However, 40 CFR 264.601, is relevant and appropriate because it addresses a similar activity (e.g., consolidated shot) that may be conducted at this MRS during the remedial action.

Notes:
CFR Code of Federal Regulations
MRS Munitions Response Site

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3.0 IDENTIFICATION OF GENERAL RESPONSE ACTIONS AND TECHNOLOGIES, AND SCREENING OF TECHNOLOGY PROCESS OPTIONS

This section identifies general response actions and technologies utilized for MEC remediation and screens their constituent technology process options based on criteria specific to the MRS.

3.1 General Response Action Identification

Remedial alternatives are developed from general response actions to satisfy the RAOs for an MRS. The general response actions available for remedial alternative development to address MEC are relatively limited and differ from those used for MC or other environmental contaminants (U.S. Army, 2009). As a result, only the following three general response actions are considered for the MRS:

- **No Action**—The No Action alternative is evaluated to satisfy the NCP requirement of 40 CFR 300.430(e)(6), which requires consideration of this alternative as a baseline against which other alternatives may be compared.
- **Risk Management**—Risk management, which is considered a "limited" action alternative by EPA, includes administrative mechanisms, engineering controls, and educational controls.
- **MEC Removal**—MEC can be detected and removed from the ground surface and/or below the ground surface. MEC removal includes technologies for detection, removal, and disposal.

3.2 Identification of Munitions and Explosives of Concern Remediation Technologies

The general response actions identified above utilize a limited number of technologies to remediate MEC. Risk management utilizes administrative mechanisms, engineering controls, and educational controls while MEC removal utilizes detection, removal, and disposal technologies. These technologies consist of individual technology process options which are screened for further consideration and alternative development. The process option screening process is detailed in the next section.

3.3 Screening of Munitions and Explosives of Concern Remediation Technology Process Options

MEC remediation technology process options are screened in the following sections. The screening evaluation is conducted in a two-step process. The initial screening step is conducted to remove from further consideration the technology process options that are not technically implementable based on site-specific conditions. The second screening step evaluates the remaining technology process options for effectiveness, implementability, and cost to determine their viability for alternative development. The development and screening of alternatives are

described in Section 4. The screening criteria used in the second step are described in Section 3.3.1.

3.3.1 Screening Criteria

MEC remediation technology process options are screened for effectiveness, implementability, and cost, to ensure that minimum standards are met. The technology process options screening criteria are described below. The technology process options screening is presented in Section 3.3.2 through Section 3.3.5.

3.3.1.1 Effectiveness

In accordance with 1988 EPA guidance, identified technologies and process options are evaluated on their effectiveness relative to other processes within the same technology/alternative type. This evaluation focuses on three criteria:

(1) The potential effectiveness of the technology and process options in handling the estimated areas or volumes of media and meeting the RAOs.

(2) The potential impact to human health and the environment during the removal or implementation phase.

(3) How proven and reliable the technology and process options are with respect to the MEC and conditions at the site.

3.3.1.2 Implementability

Implementability, as a measure of both technical and administrative feasibility, is used during screening to evaluate technology/process options with respect to conditions specific to the MRS. Technical feasibility refers to the ability to construct and reliably operate a technology/process option. Administrative feasibility refers to the ability to obtain approvals from other offices and agencies; the availability of treatment, storage, and disposal services (including capacity); and the requirements for and availability of necessary equipment, skilled workers, and technical specialists (EPA, 1988).

3.3.1.3 Cost

Cost plays a limited role in the screening of technology/process options. Relative capital and operation and maintenance (O&M) costs are used rather than detailed cost estimates. For this screening step, the cost analysis is based on engineering judgment. Each process option is evaluated as to whether its cost is high, low, or medium relative to other process options in the same technology (EPA, 1988).

3.3.2 Risk Management Technologies

Risk management or Land Use Controls (LUCs) include technologies developed to protect human health from the presence of hazards without actively remediating the source of the hazard (i.e., removal and disposal of MEC from an MRS).

LUCs include the following technologies: administrative mechanisms, engineering controls, or educational controls that warn of potential hazards or limit access to mitigate risk associated with potential human exposure to explosive hazards. The Interim LUCs detailed in the *Non-Time Critical Removal Action Land Use Control Plan* (NTCRA LUCP) were placed on the MRS in 2012 (URS/Arcadis, 2012). An Institutional Analysis (IA) was performed (**Appendix B**) to collect data to support the implementation of a LUC program. Additionally, the IA screened the current interim LUCs (administrative mechanisms and educational controls) and additional LUCs (engineering controls) for effectiveness, implementability, and cost to determine their viability.

The current interim LUC screening conducted in the IA determined that the administrative and educational controls implemented by the NTCRA LUCP were viable for implementation at the MRS. The engineering control screening conducted in the IA determined that fencing and signage were viable for potential implementation at MRSs located at West Point; however, West Point has indicated that fencing and signage are not viable for the MRS for the following reasons:

- The MRS is a remotely located area with controlled access and a limited number of annual visitors.
- The MRS is located on Constitution Island (a specially managed site) and the installation of fencing would prevent recreationist access to its historic features.
- Public advisories would as effective as signs without the additional maintenance requirements.

The viable LUC technologies and technology process options for the MRS are presented in **Table 3-1**.

Table 3-1 Viable Land Use Control Technology Process Options Summary for the Siege Battery – Constitution Island Munitions Response Site

Administrative Mechanisms	Educational Controls	Engineering Controls
• Land Use Restrictions • Master Plan Notation • Excavation (“Dig”) Permit Program • Annual Review	• Public Advisories	• None.

3.3.3 Munitions and Explosives of Concern Detection

MEC detection includes the methods and instruments used to locate surface and subsurface MEC. The best detection method is selected based on MEC properties, including the depth and size of the suspected MEC, and the physical characteristics of the MRS (e.g., soil type, topography, vegetation, and local geology).

There are two basic forms of MEC detection:

- Visual searching—Successfully used at a number of MRSs where MEC is located on the ground surface. When performing a visual search of an MRS, the area to be searched is typically divided into 5-foot lanes that are systematically inspected for MEC. A metal detector is sometimes used to supplement the visual search in areas where ground vegetation may conceal surface MEC. Typically, any MEC found during these searches is flagged or marked for immediate disposal.
- Geophysics—Includes various detection instruments designed to locate subsurface MEC, and is integrated with the equipment and methods used for location positioning. Each piece of equipment has its own inherent advantages and disadvantages based on its operating characteristics. Therefore, selecting the appropriate type of geophysical instrument is critical to survey success. The instruments designed to locate subsurface MEC include magnetometers and electromagnetic instruments. Positioning technologies include various equipment and instruments that establish geo-referenced positions for detected subsurface anomalies. The viability of positioning technologies is affected by site-specific conditions, including terrain, tree canopy, and vegetation density.

MEC detection and positioning technology process options are described and screened using a two-step process (refer to Section 3.2) in **Table 3-2** and **Table 3-3**, respectively.

Table 3-2 Munitions and Explosives of Concern Detection Technology Process Option Screening

Process Option	Technical Implementability	Effectiveness	Implementability	Cost	Representative Systems	Viability and Retention
Visual Searching: Search area is typically divided into 5-foot lanes that are systematically inspected for MEC on the surface. A hand-held geophysical sensor is sometimes used to assist the visual search in areas where ground vegetation or leaf litter may conceal surface MEC. Any MEC found during these searches is flagged or marked for immediate disposal. Notes: Typically supported with a flux-gate magnetometer or FDEMI metal detector. This technology is typically used for surface removal projects and as a preliminary step in removing surface metal and MEC in support of subsurface removal.	**Retained:** This process option is technically implementable for this MRS.	**Low:** Not effective in vegetated areas such as the MRS due to ground cover Cannot detect subsurface MEC. Must be used in conjunction with another process option capable of detecting subsurface MEC. MRS is densely forested, hindering unassisted visual identification. Minimal to no impact on cultural or natural resources.	**High:** Easily implemented process option that uses readily available equipment and workers.	**Low:** Low cost relative to other detection systems.	Not Applicable	**Retained:** This process option is viable and has been retained because it is low cost and highly implementable.
Flux-Gate Magnetometers: Flux-gate magnetometers measure the vertical component of the geomagnetic field along the axis of the sensor and not the total intensity of the geomagnetic field. Notes: Detects ferrous objects only. Light and compact. Flux-gate magnetometers are commonly used for mag and dig surveys to detect both surface and subsurface MEC. High industry familiarization.	**Retained:** This process option is technically implementable for this MRS because the MEC at the MRS are ferrous, and located at a detectable depth.	**Medium:** Effectively detects surface and subsurface MEC located at the MRS; however, the high iron content in the local geology could lead to the investigation of numerous false positives (anomalies). Minimal to no adverse effect on cultural or natural resources.	**High:** Easily implemented process option that uses readily available equipment and workers.	**Low:** Low cost relative to other detection systems.	Chicago Steel Tape (Magna-Trak 102) Ebinger MAGNEX 120 LW Foerster FEREX 4.032 Foerster FEREX 4.032 DLG Schonstedt GA-72CX Vallon EL1302D1 or 1303D	**Retained:** This process option is viable and has been retained because it is effective, low cost, and highly implementable.
Optically Pumped Magnetometers: This technology is based on the theory of optical pumping and operates at the atomic level, rather than proton precession magnetometers, which operate at the nuclear level. Notes: Detects ferrous objects only. Standard detector for UXO detection. High industry familiarization.	**Retained:** This process option is technically implementable for this MRS because the MEC at the MRS are ferrous, and located at a detectable depth.	**Medium:** Effectively detects surface and subsurface MEC located at the MRS; however, the high iron content in the local geology could lead to the investigation of numerous false positives (anomalies). Minimal to no adverse effect on cultural or natural resources.	**Medium:** Easily implemented process option that uses readily available equipment. Requires trained specialists to process and interpret data.	**Medium:** Medium cost relative to other detection systems.	GEM Systems GSMP-40 Geometrics G-858 Geometrics G-822 Scientrex Smart Mag	**Retained:** This process option is viable and has been retained because it is effective and implementable with costs that are not excessive.

Process Option	Technical Implementability	Effectiveness	Implementability	Cost	Representative Systems	Viability and Retention
FDEMI Metal Detectors: FDEMI sensors generate one or more defined frequencies in a continuous mode of operation. Notes: Detects both ferrous and non-ferrous metallic objects. Moderate industry familiarization. The White's All-Metals Detector was proven effective during the RI at this MRS.	**Retained:** This process option is technically implementable for this MRS because it was effectively used during the RI.	**High:** Effectively detects surface and subsurface MEC located at the MRS. Minimal to no adverse effect on cultural or natural resources.	**High:** Easily implemented process option that uses readily available equipment and workers.	**Low:** Low cost relative to other detection systems.	Fisher 1266X Foerster MinexMinelabs Explorer II White's All Metals Detector	**Retained:** This process option is viable and has been retained because it is highly effective and implementable and requires low cost.
TDEMI Metal Detectors: TDEMI is a technology used to induce a pulsed magnetic field beneath the earth's surface with a transmitter coil, which in turn causes a secondary magnetic field to emanate from nearby objects that have conductive properties. Notes: Detects ferrous and non-ferrous metallic objects. High industry familiarization. Detection depths are highly dependent on coil size and transmitter power.	**Retained:** This process option is technically implementable for this MRS if used following significant vegetation removal (i.e., clearcutting of part or all of the MRS) and in areas where steep terrain are not present because the MEC at the MRS are ferrous, and located at a detectable depth.	**Medium:** Effectively detects surface and subsurface MEC located at the MRS in clearcut areas and areas free of steep terrain. Cannot be used alone. Minor adverse effect on cultural or natural resources based on clearcutting.	**Medium:** Easily implemented process option that uses readily available equipment and workers. Reliably operated in clearcut areas and areas free of steep terrain.	**Medium – High:** Medium to high cost relative to other detection systems.	Geonics EM61-MK1 Geonics EM61-MK2 Geonics EM61-MK2 HP Geonics EM61 HH Geonics EM63 G-tek/GAP TM5-EMU Schiebel AN PSS-12 Vallon VMH3	**Retained:** This process option is viable and has been retained because it is effective and implementable with costs that may not be excessive.
Ground Penetrating Radar: GPR works by propagating electromagnetic waves into the ground via an antenna. These transmitted signals are reflected by objects and features that possess contrasts in electrical properties with the surrounding medium. Notes: Detects both metallic and non-metallic objects. Medium industry familiarization. Data output is usually viewed in transects not maps.	**Retained:** This process option is technically implementable for this MRS because the MEC at the MRS are ferrous, and located at a detectable depth.	**Low:** Effectiveness limited by variable environmental and geological conditions. Requires clearcut areas and areas free of steep terrain. Cannot be used alone.	**Medium:** Easily implemented process option that uses readily available equipment and workers. Reliably operated only in clearcut areas and areas free of steep terrain.	**High:** High cost relative to other detection systems.	GSSI SIR2, SIR3, SIR8, SIR10 RAMAC Software Sensors & Software PulseEKKO Pro	**Not Retained:** This process option is not viable and has not been retained because it is not effective and requires excessive costs.
Advanced EMI Sensors and Anomaly Classification: Advanced sensors have the ability to precisely capture measurements from enough locations to sample all principal axis responses of an anomaly or item of interest. Provides the necessary information for analysis and classification of hazardous and non-hazardous items. Notes: Sensors have limited industry availability. Requires advanced training and certification for operation, data processing, and analysis.	**Not Retained:** This process option is not technically implementable for this MRS due to the presence of steep terrain, which prevent use of the large sensors that are required.					

Process Option	Technical Implementability	Effectiveness	Implementability	Cost	Representative Systems	Viability and Retention
SAM: SAM is a patented methodology. A total field magnetic sensor is used to simultaneously acquire both magnetic and electromagnetic response of subsurface conductive items. Notes: Not commercially available. No established performance track record.	**Not Retained:** This process option is not technically implementable for this MRS because it is not commercially available and has not yet been proven reliable (i.e., no established track record of performance).					
Magnetometer-Electromagnetic Detection Dual Sensor Systems: Utilizes large dual sensor systems to detect surface and subsurface MEC. Notes: Detects both metallic and non-metallic objects. Commercially available.	**Not Retained:** This process option is not technically implementable for this MRS due to the presence of steep terrain, which prevent use of the large dual sensor systems that are required.					
Airborne SAR: This airborne method uses strength and travel time of microwave signals that are emitted by a radar antenna and reflected off a distant surface object. Notes: No established performance track record.	**Not Retained:** This process option is not technically implementable for this MRS because it only detects large surface objects.					
Airborne LIDAR: Uses a pulsed laser directed towards the ground and mounted from relatively high-flying aircraft to detect MEC. GPS and inertial navigation systems are used to precisely measure the position and orientation of the laser.	**Not Retained:** This process option is not technically implementable for this MRS because it cannot reliably detect small items of MEC and it cannot detect subsurface MEC. Small items of MEC are expected and subsurface MEC may be present at this MRS based on the results of the SI/RI.					

Notes:

EMI	Electromagnetic Induction	FDEMI	Frequency-Domain Electromagnetic Induction
GPR	Ground Penetrating Radar	LIDAR	Light Detection and Ranging
MEC	Munitions and Explosives of Concern	MRS	Munitions Response Site
RI	Remedial Investigation	SI	Site Inspection
SAM	Sub Audio Magnetics	SAR	Synthetic Aperture Radar
TDEMI	Time-Domain Electromagnetic Induction	UXO	Unexploded Ordnance

Table 3-3 Positioning System Technology Process Option Screening

Process Option	Technical Implementability	Effectiveness	Implementability	Cost	Representative Systems	Viability and Retention
DGPS: An advanced form of GPS, which can provide locations to sub-centimeter accuracy. This system requires the use of a base station or subscription service to correct for errors in positioning and other sources, including clock errors, atmospheric effects, and signal reflections. Notes: DGPS is the primary navigation method for munitions geophysical surveys.	**Retained:** This process option is technically implementable for this MRS if used following significant vegetation removal (i.e., clearcutting of part or all of the MRS) because it can provide accurate positioning data.	**Low – High**: Effective positioning technology limited by tree cover present at the MRS; however, effectiveness increases significantly following vegetation removal (partial or clearcut) from the MRS. Minor adverse effect on cultural or natural resources based on clearcutting.	**Medium**: Easily implemented process option that uses readily available equipment and workers. Reliably operated in clearcut areas.	**Medium**: Medium cost relative to other positioning systems.	Hemisphere S320 OmniSTAR VBS/HP Trimble Model 5800	**Retained:** This process option is viable and has been retained because it is effective and implementable with costs that are not excessive.
RTS: RTS is a laser-based survey station that derives its position from survey methodology. Includes a servo-operated mechanism that tracks a prism mounted on the geophysical sensor. Notes: Typically used with TDEMI metal detectors (e.g., Geonics EM61-MK2) and digital magnetometers (e.g., Geometrics G-858). This process option was used for anomaly reacquisition during the RI. RTS can also be used for data positioning for digital detector systems in moderately wooded areas.	**Retained:** This process option is technically implementable for this MRS because it was effectively used during the RI.	**Medium – High**: Effective positioning technology limited by wooded terrain present at the MRS; however, effectiveness increases following vegetation removal (partial or clearcut) from the MRS. Minor adverse effect on cultural or natural resources based on clearcutting.	**Medium – High**: Easily implemented process option that uses readily available equipment and workers. More reliably operated in clearcut areas.	**Medium**: Medium cost relative to other positioning systems.	Leica RTS 1200 Trimble Model 5600	**Retained:** This process option is viable and has been retained because it is effective and implementable with costs that are not excessive.
Fiducial Method: The fiducial method consists of digitally marking a data string with an indicator of a known position. Typically, markers are placed on the ground at known positions (e.g., 25 feet). Notes: Useful method if digital positioning systems are unavailable. This process option was used during the RI at this MRS.	**Retained:** This process option is technically implementable for this MRS because it can provide accurate positioning data.	**High**: Effective positioning technology not limited by wooded terrain present at the MRS. Minimal to no adverse effect on cultural or natural resources.	**Medium**: Easily implemented process option that uses readily available equipment. Requires trained specialists to process and interpret data.	**Low**: Low cost relative to other positioning systems.	Not Applicable	**Retained:** This process option is viable and has been retained because it is highly effective and implementable with low costs.

Notes:

DGPS	Differential Global Positioning System	GPS	Global Positioning System
MRS	Munitions Response Site	RI	Remedial Investigation
RTS	Robotic Total Station	TDEMI	Time-Domain Electromagnetic Induction

3.3.4 Munitions and Explosives of Concern Removal

Removal operations can take the form of a surface-only removal, an intrusive (subsurface) removal, or a combination of the two methods. The decision on the appropriate level of removal operation is based on the nature and extent of the hazards as well as the current land use and intended future land use of the MRS.

For a surface removal operation, exposed MEC or suspected hazardous items are identified during the detection phase. The MEC are then inspected, identified, collected (if possible), and transported to a designated area for cataloging and eventual disposal. MEC cannot be removed from the MRS unless EOD authorizes. MEC can only be moved within an MRS if the SUXOS and UXOSO agree that the item is acceptable to move. If it is determined during the inspection that an item is unacceptable to move, then it may be necessary to destroy the item in place.

Potential subsurface MEC identified by a geophysical survey or other detection methods requires excavation for removal or detonation. Because the actual nature of the buried item cannot be determined without it being uncovered, the evacuation of non-essential personnel is necessary within a predetermined minimum separation distance (MSD). The MSD is based on the munition with the greatest fragmentation distance that may be present within the MRS. All non-essential personnel and the general public must be evacuated from and maintain their distance beyond the MSD during the intrusive operation. Potential MEC is excavated using hand tools. Once an item has been exposed, it is then inspected, identified, collected (if possible), and transported to a designated area for cataloging and disposal. MEC cannot be removed from the MRS unless EOD authorizes. MEC can only be moved within an MRS if the SUXOS and UXOSO agree that the item is acceptable to move. If it is determined during the inspection that the item is unacceptable to move, then it may be necessary to destroy the item in place. For intentional detonations, all personnel must observe the MSD. The MSD may be increased or decreased based on the actual item identified and may also be reduced if engineering controls are used. The MSD may only be changed through an amendment to an approved Explosives Safety Submission (ESS). MEC removal technology process options are described and screened using a two-step process (refer to Section 3.2) in **Table 3-4**.

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Table 3-4 Munitions and Explosives of Concern Removal Technology Process Option Screening

Process Option	Technical Implementability	Effectiveness	Implementability	Cost	Representative Systems	Viability and Retention
Hand Excavation: Technique includes digging individual anomalies using commonly available hand tools. Notes: This technology was successfully used during the RI at this MRS. This process option is considered the industry standard for MEC removal.	**Retained:** This process option is technically implementable for this MRS because it was effectively used during the RI.	**High**: Highly effective process option for removing the small quantity of MEC expected at this MRS. Minimal to no adverse effect on cultural or natural resources.	**High**: Easily implemented process option that uses readily available equipment and workers. Requires readily obtained dig permits.	**Low**: Low cost relative to other removal techniques.	Probe, trowel, shovel, pick axe.	**Retained:** This process option is viable and has been retained because it is highly effective and implementable with low costs.
Mechanical Excavation of Individual Anomalies: This method uses commonly available mechanical excavating equipment to support hand excavation. The equipment would need to be armored to protect the operator. Notes: Easy to rent and operate.	**Not Retained:** This process option is not technically implementable at this MRS because the steep terrain would significantly reduce the effectiveness of mechanical excavating equipment.					
Mass Excavation and Sifting: Armored excavation and transportation equipment protects the operator and equipment from unintentional detonation. Once soil is excavated and transported to the processing area, it is then processed through a series of screening devices and conveyors to segregate MEC from soil. Notes: Can be rented and armor installed, and equipment delivered almost anywhere. Significant maintenance costs.	**Not Retained:** This process option is not technically implementable at this MRS because the steep terrain would significantly reduce the effectiveness of mechanical excavating equipment.					
Magnetically Assisted Removal: Magnets are used to separate conductive material from soil. Notes: Installed by sifting equipment owner.	**Not Retained:** This process option is not technically implementable at this MRS because Mass Excavation and Sifting is not technically implementable and this process option is used in conjunction with Mass Excavation and Sifting.					
Remotely Operated Removal Equipment: This option has additional controls that allows the equipment to be operated remotely. Notes: EOD robots are almost exclusively used for military and law enforcement reconnaissance and render-safe operations.	**Not Retained:** This process option is not technically implementable at this MRS because it has not been proven to be an effective MEC removal method.					

Notes:
EOD Explosive Ordnance Disposal MEC Munitions and Explosives of Concern MRS Munitions Response Site RI Remedial Investigation

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3.3.5 Munitions and Explosives of Concern Disposal

Recovered MEC is normally destroyed on-site, either at the location of discovery or at the location on the MRS that has been sited and approved. In some cases, recovered MEC may be transported off the MRS for destruction. The decision regarding the disposition of any recovered MEC is determined by qualified personnel based on site-specific characteristics and the nature of the recovered MEC. MEC disposal technology process options are described and screened using a two-step process (refer to Section 3.2) in **Table 3-5**.

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Table 3-5 Munitions and Explosives of Concern Disposal Technology Process Option Screening

Process Option	Technical Implementability	Effectiveness	Implementability	Cost	Representative Systems	Viability and Retention
BIP: BIP is used to destroy MEC for which the risk of movement beyond the immediate vicinity of discovery is considered not acceptable. Normally, BIP is accomplished by placing an explosive charge alongside the MEC. Notes: Disposition of resultant waste streams must be addressed in BIP operations planning.	**Retained:** This process option is technically implementable for this MRS because it can effectively destroy the MEC expected at the MRS.	**High:** Effective because it permanently eliminates the explosive hazard associated with MEC. Requires engineering controls. Major adverse effect on cultural and natural resources if item cannot be moved away from sensitive cultural or natural resources for detonation.	**Low – High:** Easily implemented process option with readily available equipment and workers. Engineering controls further increase implementability. Proximity to cultural resources can severely limit the implementability of this process option.	**Medium:** Medium cost relative to other disposal techniques.	Electric Demolition Procedures Non-electric Demolition Procedures (e.g., Non-el, Time Fuse)	**Retained:** This process option is viable and has been retained because it is highly effective and implementable with costs that are not excessive.
Consolidated Shots: Consolidated shots include the collection, configuration, and subsequent destruction by explosive detonation of MEC that has been deemed acceptable to move, either within the MRS or to an established demolition ground. Notes: Disposition of resultant waste streams must be addressed. Increased areas require additional access and safety considerations.	**Retained:** This process option is technically implementable for this MRS because it can effectively destroy the MEC expected at the MRS.	**High:** Effective because it permanently eliminates the explosive hazard associated with MEC. Only conducted for MEC deemed acceptable to move. Requires engineering controls. Minimal to no adverse effect on cultural and natural resources because items can be moved away from cultural or natural resources for detonation.	**Medium – High:** Easily implemented process option with readily available equipment and workers. Engineering controls further increase implementability.	**Medium:** Medium cost relative to other disposal techniques.	Electric Demolition Procedures Non-electric Demolition Procedures (e.g., Non-el, Time Fuse)	**Retained:** This process option is viable and has been retained because it is highly effective and implementable with costs that are not excessive.
CDCs—Stationary/Mobile: CDCs involve destruction of certain types of munitions in a chamber, vessel, or facility designed and constructed specifically for the purpose of containing blasts and fragments. CDCs can only be employed for MEC that has been deemed acceptable to move. Notes: System cleaning and maintenance usually requires PPE and worker training. Probable permitting issues with employment of technology.	**Retained:** This process option is technically implementable at this MRS because it can effectively destroy the MEC expected at the MRS.	**Low – High:** CDCs are highly effective because they are proven and reliable systems utilized to dispose of munitions in a safe and environmentally sound manner. However, CDCs can only be utilized with munitions that are deemed acceptable to move.	**Medium:** Stationary/Mobile CDCs and the workers to operate them are readily available. These systems typically must meet regulatory standards required for permanent/semi-permanent waste disposal facilities.	**High:** High capital and operation and maintenance costs relative to other disposal techniques.	Stationary: Typically designed on case-by-case basis. Mobile: Donovan Blast Chamber Kobe Blast Chamber	**Not Retained:** This process option is not viable and has not been retained because it requires excessive costs and is not more effective or implementable than the other disposal technology process options.
Chemical Decontamination: Uses chemical processes to eliminate all explosives residues from MEC. Notes: National Defense Center for Energy and Environment is working on a mobile system, but it treats only scrap metal and not MEC.	**Not Retained:** This process option is not technically implementable at this MRS because MC or bulk explosives were not detected at the MRS.					

Process Option	Technical Implementability	Effectiveness	Implementability	Cost	Representative Systems	Viability and Retention
Thermal Treatment: Explosive residue from MEC is destroyed by exposing debris to high temperatures (between 600 and 1,400 degrees Fahrenheit) for specified periods of time.	**Not Retained:** This process option is not technically implementable at this MRS because MC or bulk explosives were not detected at the MRS.					
Laser Initiation: Portable (vehicle mounted) lasers are used from a safe distance to destroy UXO or DMM lying on the ground surface. Notes: Offers added safety through significant stand-off (up to 300 meters). Acceptable safety stand-offs must be evaluated for specific MEC types and location scenarios. ZEUS prototype deployed/employed in Afghanistan (2003).	**Not Retained:** This process option is not technically implementable at this MRS because it has not been demonstrated to be reliable.					

Notes:

BIP	Blow-in-Place	CDCs	Contained Detonation Chambers	DMM	Discarded Military Munitions
MEC	Munitions and Explosives of Concern	MRS	Munitions Response Site	PPE	Personal Protective Equipment
RI	Remedial Investigation	UXO	Unexploded Ordnance		

3.3.6 Viable Munitions and Explosives of Concern Remediation Technologies and Process Options for the Siege Battery – Constitution Island Munitions Response Site

The viable LUC technologies and process options for the MRS are summarized in **Table 3-1**. The viable technology process options listed in **Table 3-2** through **Table 3-5** for the MRS are summarized in **Table 3-6**, and are included in the development of remedial alternatives in Section 4.

Table 3-6 Viable Munitions and Explosives of Concern Remediation Technologies and Process Options for the Siege Battery – Constitution Island Munitions Response Site

MEC Detection		MEC Removal	MEC Disposal
Geophysical Detection	**Positioning**		
• Visual Searching • Flux-Gate Magnetometers • Optically Pumped Magnetometers • TDEMI Metal Detectors • FDEMI Metal Detectors	• DGPS • RTS • Fiducial Method	• Hand Excavation	• BIP • Consolidated Shots

Notes:

BIP	Blow-in-Place
DGPS	Differential Global Positioning System
FDEMI	Frequency-Domain Electromagnetic Induction
MEC	Munitions and Explosives of Concern
RTS	Robotic Total Station
TDEMI	Time-Domain Electromagnetic Induction

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4.0 DEVELOPMENT AND SCREENING OF ALTERNATIVES

In this section, the technologies and process options deemed viable for use at the MRS are combined to form remedial alternatives. In accordance with DoD Manual 4715.2, an FS must consider at least the following three alternatives: (1) No Action (baseline), (2) action that requires LUCs, and (3) remediation to an unlimited use and unrestricted exposure (UU/UE) condition. For the purpose of this evaluation, UU/UE is defined as conditions that indicate a "negligible probability" of encountering MEC based on a comprehensive assessment of current and previous land use (EM 385-1-97).

MEC remedial alternatives are evaluated against short-term and long-term aspects of three broad criteria: (1) effectiveness, (2) implementability, and (3) cost. Because the purpose of the alternatives screening evaluation is to reduce the number of alternatives that will undergo detailed analysis against the nine criteria, alternatives are evaluated more generally in this step than during the detailed analysis (EPA, 1988). The three screening criteria are described below.

4.1 Alternatives Screening Criteria

4.1.1 Effectiveness

A key aspect of the screening evaluation is the effectiveness of each alternative in protection of human health and the environment. The focus of the effectiveness screening criterion is the degree to which the alternative reduces toxicity, mobility, or volume through treatment, minimizes residual explosive hazards and provides long-term protection, complies with ARARs, and minimizes short-term effects. Also taken into consideration is how quickly the alternative achieves protection of human health and the environment. Alternatives that provide significantly less effectiveness than other, more promising, alternatives may be eliminated. Alternatives that do not provide adequate protection of human health and the environment are eliminated from further consideration [40 CFR 300.430(e)(7)(i)].

4.1.2 Implementability

The implementability screening criterion focuses on the technical feasibility and availability of the technologies that comprise the alternative. Similar to the implementability screening of technologies/process options, technical feasibility for the alternatives screening includes the ability to construct, reliably operate, and meet technology-specific regulations until a remedial action is complete. Technical feasibility also includes operation, maintenance, replacement, and monitoring of technical alternative components, if required, after the remedial action is complete. The administrative feasibility of implementing the alternative is also evaluated. Administrative feasibility includes the ability to obtain approvals from stakeholders, the availability of treatment, storage, and disposal services and capacity, and the requirements for, and availability of, specific equipment and technical specialists. Alternatives that are technically or administratively infeasible or that would require equipment, specialists, or facilities that are not available within a reasonable

period of time may be eliminated from further consideration [EPA, 1988; 40 CFR 300.430(e)(7)(ii)].

4.1.3 Cost

The costs of construction and any long-term costs to operate and maintain the alternative are considered in the cost screening criterion. Ranges or approximations of relative capital and O&M costs are used rather than detailed estimates. It is not necessary that the costs of alternatives be defined with the accuracy desired for the detailed analysis (i.e., + 50% to –30%). The evaluation of costs includes those O&M costs that will be incurred for as long as necessary, even after the initial remedial action is complete. Present value analyses are used to evaluate expenditures that occur over different time periods. All costs are discounted to a common base year. Alternatives whose costs are grossly excessive compared to their overall effectiveness may be eliminated from further consideration. An alternative that provides similar effectiveness and implementability to that of another alternative by employing a similar method of treatment or engineering control, but at greater cost, may also be eliminated from further consideration [40 CFR 300.430(e)(7)(iii); EPA, 1988].

4.2 Alternative 1—No Action

Alternative 1 would not require the Army to remove any potential MEC present within the MRS, and the LUCs implemented at the MRS as part of the NTCRA LUCP would be allowed to expire. In addition, no public awareness or education training would be provided with regard to the hazards associated with MEC. Further, it is assumed that current land use of the MRS would not change. It is important to note that the Army would respond to any future MEC discoveries at the MRS, if this alternative is selected. This alternative will be utilized for comparison with the other alternatives; therefore, this alternative will not be screened and will be analyzed as a potential alternative.

4.3 Alternative 2—Risk Management

4.3.1 Description of Alternative 2

Alternative 2 would implement LUCs to reduce the potential for human receptor exposure to the explosive hazards posed by MEC at the MRS. These LUCs would include the administrative mechanisms and educational controls detailed in the Institutional Analysis (**Appendix B**). A LUCP would be prepared to detail LUC implementation at the MRS. The extent of the LUCs is presented in **Figure 4-1**. Because this alternative would result in MEC remaining at the MRS, Five-Year Reviews would be performed no less often than every five years after initiation of the remedial action until the MRS qualifies for UU/UE. Five-Year Reviews would include the following general steps:

- Existing documentation review.
- New information and current site conditions review and identification.

- Five-Year Review report preparation.

The following LUCs would be implemented at the MRS:

- Land Use Restrictions—Use of the MRS for residential purposes, daycare facilities, hospitals, or schools would be prohibited without prior approval from West Point.
- Master Plan Notation—The installation master plan would include a notation requiring a record of all 911 calls involving MEC in a geographic information system database to facilitate explosive hazard delineation.
- Dig Permits—Dig permits and construction support would be required whenever ground is broken at the MRS. There is a moderate to high probability of encountering MEC at the MRS; therefore, on-site construction support according to the *Probability Assessment for Determining the Probability of Encountering MEC* would be required when intrusive activities are performed (West Point, 2016).
- Public Advisories—Brochures (e.g., 3Rs pamphlet) detailing the potential hazards associated with MEC would be developed and provided to the Constitution Island Caretaker and the recreationists visiting the RWE and Redoubt No. 7.
- Annual Review—LUCs will be reviewed annually by West Point.

In the event that a suspected munition is discovered by the Constitution Island Caretaker, recreational user, or contractor personnel, the location of the suspected munition would be marked and installation officials notified (i.e., 3Rs protocol). Installation officials would assume control and security of the item until such time as the responding explosive ordnance disposal (EOD) team arrived on site. The responding EOD team would dispose and/or remove the item in accordance with current EOD procedures.

4.3.2 Screening of Alternative 2

- Effectiveness: This alternative would protect human health by reducing human receptor contact with MEC through restricting land use and modifying/guiding human behavior. This alternative would not primarily reduce the TMV of MEC at the MRS; however, it would reduce the TMV of MEC following MEC discovery and disposal, but would not satisfy the statutory preference for treatment as a principal element of the selected remedy. This alternative would affect workers and the /recreationists in the short-term in those instances where MEC is discovered and disposal is required. Short-term effects to the Constitution Island Caretaker/recreationists and EOD personnel would be minimized by the use of engineering controls. Short-term effects to EOD personnel would be further minimized through use of personal protective equipment and as a result of their specialized training. This alternative would comply with the substantive requirements of 40 CFR 264.601 (Environmental Performance Standards) by utilizing exclusion zones, engineering controls, and EOD personnel when performing a consolidated shot. This alternative would

require approximately six months to employ to reduce human receptor exposure to the explosive hazards posed by MEC located at the MRS.

- Implementability: The LUCs included in this alternative would be technically and administratively feasible because similar LUCs were implemented on an interim basis by West Point, and West Point approved of their use in the past.
- Cost[1]: The total present value of this alternative would be $277,741. The total present value was derived from capital ($57,417), annual O&M ($49,967), and periodic ($242,992) costs based on a discount rate of 1.5% over a 30-year period.

Alternative 2—Risk Management would effectively protect human receptors from the explosive hazards posed by MEC. Alternative 2 is also readily implementable. The costs for Alternative 2 would not be grossly excessive compared to its overall effectiveness. Therefore, Alternative 2 will be analyzed as a potential alternative for the MRS.

4.4 Alternative 3—Munitions and Explosives of Concern Removal to Qualify for Unlimited Use and Unrestricted Exposure

4.4.1 Description of Alternative 3

Alternative 3 would include removal of MEC from all 52 acres of the MRS. The removal of MEC from the MRS would result in UU/UE qualification. The extent of the MEC removal is presented in **Figure 4-2**. This alternative consists of the following general components: planning document preparation, clearcutting and grubbing, surface MEC removal, and subsurface MEC removal.

The following planning documents would be prepared for this alternative: work plan, ecological resources plan, accident prevention plan/site safety and health plan, uniform federal policy–quality assurance project plan, ESS, and storm water pollution prevention plan. Clearcutting and grubbing of the MRS would follow planning document preparation.

In preparation for clearcutting and grubbing, an exclusion zone would be established to prohibit unauthorized access and protect human receptors from the explosive hazards posed by MEC identified during field activities. Access to the MRS would be restricted via land by utilizing construction barriers, caution tape, and warning signs installed around the perimeter of the exclusion zone. Access to the MRS would be restricted via water by performing patrols in the Hudson River to prevent boater access. The exclusion zone would be based on the MGFD that may be present within the MRS. Previous investigations discovered a 3-inch Stokes mortar and unidentified munitions fragments at the MRS. Therefore, the exclusion zone would be based on the hazardous fragment distance (HFD) associated with the unintentional detonation of a 3-inch Stokes mortar. The HFD associated with the unintentional detonation of a 3-inch Stokes mortar is 219 feet (Weston, 2010). The exclusion zone for Alternative 3 is presented in **Figure 4-2**. The

[1] *Total costs may vary from supporting estimates due to rounding.*

Constitution Island Caretaker/recreationists and non-essential personnel would be prevented from entering the exclusion zone during alternative implementation.

Clearcutting and grubbing would be performed with hand tools and armored mechanical equipment (e.g., excavator, hydraulic axe, and/or brush hog). The clearcutting and grubbing team would be assisted by a Department of Defense Explosives Safety Board (DDESB) TP-18 qualified individual to conduct UXO avoidance activities using a handheld magnetometer (e.g., optically pumped, flux-gate, or FDEMI). Cleared and grubbed vegetation would be mulched, temporarily stored on-site in an area previously cleared of MEC, and trucked off-site for use on Constitution Island by West Point. Surface MEC removal activities would follow clearcutting and grubbing.

During the surface MEC removal, all anomalies would be identified and managed according to an approved ESS, EM 385-1-97/Department of Defense Manual (DoDM) 6055.09M. The surface MEC removal team would be composed of DDESB TP-18–qualified personnel. For the surface MEC removal, a state licensed surveyor would establish several control points and the MEC removal team would subdivide the MRS into 100-foot by 100-foot grids with each grid containing no less than 20 parallel lanes. Each lane would be surface swept using a handheld magnetometer (e.g., optically pumped, flux-gate, or FDEMI) assisted by visual survey. Subsurface MEC removal activities would follow surface removal activities.

The subsurface MEC removal would utilize both Time-Domain Electromagnetic Induction (TDEMI) and handheld magnetometer (e.g., optically pumped, flux-gate, or FDEMI) MEC detection technology. A handheld magnetometer would be utilized in areas of the MRS too steep or otherwise inaccessible for the use of TDEMI technology (i.e., digital geophysical mapping [DGM]) because TDEMI technology requires the use of large, less mobile sensor systems than handheld magnetometer technology. Handheld magnetometer survey activities would be conducted by DDESB TP-18–qualified personnel utilizing hand tools (e.g., non-sparking shovels) and an appropriate positioning technology. Anomalies would be identified and managed according to an approved ESS, EM 385-1-97/DoDM 6055.09M.

DGM survey activities would be conducted by DDESB TP-18–qualified personnel utilizing an appropriate positioning technology. Data acquired during the DGM survey would be processed and analyzed to prepare an anomaly list for reacquisition and evaluation. A dig team consisting of DDESB TP-18–qualified personnel would reacquire each listed anomaly using a handheld magnetometer (e.g., optically pumped, flux-gate, or FDEMI) and hand tools (e.g., non-sparking shovels). Reacquired anomalies would be identified and managed according to an approved ESS, EM 385-1-97/DoDM 6055.09M.

MPPEH or MDEH identified during the handheld magnetometer and DGM surveys would be BIP or disposed by consolidated shot. The item would only be disposed by consolidated shot if SUXOS and UXOSO agree that the item is acceptable to move. The item determined to be acceptable to move must remain in the grid found. If disposal operations (i.e., BIP or consolidated shot) are conducted, then exclusion zones and engineering controls would be utilized to minimize explosive hazards; exclusion zone establishment would use the same methods described above to prohibit

access to the MRS via land and water. Disposal operations would follow EM 385-1-97 and an approved ESS.

Geophysical system verification would be conducted to evaluate detection instrument response and determine which combination of MEC detection technology process options (e.g., optically pumped, flux-gate, FDEMI, or TDEMI) should be utilized to ensure that data quality objectives are achieved. It should be noted that previously identified MEC was found on the ground surface (3-inch Stokes mortar) and MD (3-inch Stokes mortar related and unidentified munitions) was detected from one inch to eight inches bgs at the MRS. The identified munitions would be detected to a depth equivalent to 11 times their diameter or 2.8 feet below ground surface (3-inch Stokes mortar). MEC removal would be conducted in lifts to ensure that the MRS qualifies for UU/UE.

The provisions of *Standard Operating Procedure 16-1: Protection of Archaeological or Historical Artifacts* would be followed to mitigate cultural resources damage during implementation of this alternative. These cultural resources are located near and within the MRS. These provisions would include stopping work and notifying the Cultural Resource Office when a suspected artifact is found (U.S. Military Academy [USMA], 1995).

The provisions of the ecological resources plan would also be followed to mitigate ecological resources damage during implementation of this alternative. These ecological resources consist of four wetland areas totaling 2.24 acres located within the MRS (**Figure 1-3**). These provisions would include the preparation of an ecological field survey to evaluate the area in which the alternative would be conducted as well as procedures to be followed to mitigate ecological resources damage. The ecological resources plan would be prepared in accordance with EM 200-1-15 (USACE, 2013).

4.4.2 Screening of Alternative 3

- Effectiveness: This alternative would be protective of human receptors by removing surface and subsurface MEC from all of the MRS to qualify the MRS for UU/UE. This alternative would primarily reduce the TMV of MEC at the MRS and satisfy the statutory preference for treatment as a principal element of the selected remedy. The use of DDESB TP-18–qualified personnel for MEC disposal would reduce the short-term effects of alternative implementation. The need to clearcut the MRS would adversely affect the woodland ecosystem and cultural resources on the MRS. It may take several years for trees to re-establish themselves after clearcutting, and the clearcutting of the woodland ecosystem would accelerate soil erosion and may negatively affect wetlands located within and near the MRS through sedimentation. The adverse effects caused by soil erosion would be mitigated through the development and implementation of a storm water pollution prevention plan and ecological resources plan. The need to remove MEC from the MRS may adversely affect wetlands located within the MRS. The adverse effects caused by MEC removal would be mitigated through the development and implementation of an ecological resources plan. Workers and the Constitution Island Caretaker/recreationists would also be exposed to explosive hazards during removal activities as well as the hazards

(e.g., heavy equipment operation) associated with clearcutting and grubbing. This alternative would comply with the substantive requirements of 40 CFR 264.601 (Environmental Performance Standards) by utilizing exclusion zones, engineering controls, and DDESB TP-18–qualified personnel when performing a consolidated shot. This alternative would require approximately one year to employ to eliminate human receptor exposure to the explosive hazards posed by MEC located at the MRS.

- Implementability: The technology, equipment, and skilled workers required for MEC removal are readily available; however, the technical feasibility of clearcutting and grubbing would be limited by the ability to maneuver and operate heavy equipment on the MRS where steep terrain and steep cliffs are present. Clearcutting and grubbing the MRS, to remove a likely low number of MEC, would denude the entire MRS of vegetation and destroy historical artifacts, thereby reducing the aesthetic and educational value of Constitution Island (a specially managed site). Constitution Island and the MRS contain sensitive and very well-preserved cultural resources dating back to the Revolutionary War.
- Cost[2]: The total present value of this alternative would be $4,524,800. The total present value was based only on a non-discounted capital cost of $4,524,800.

Alternative 3—Removal of MEC to Qualify for UU/UE would effectively protect human receptors from the explosive hazards posed by MEC, although clearcutting and grubbing would adversely affect the woodland ecosystem, cultural resources, and wetlands located at the MRS. Alternative 3 would be implementable, although implementation would reduce the aesthetic and educational value of Constitution Island. However, the costs for Alternative 3 would be excessive because Alternative 3 and Alternative 5 are similarly effective and implementable. Alternative 3 and Alternative 5 are similarly effective and implementable because they both remove surface/subsurface MEC from the 10-acre area located in the southern portion of the MRS where the only recreational activities occur. Therefore, Alternative 3 will not be analyzed as a potential alternative for the MRS.

4.5 Alternative 4—Partial Surface Munitions and Explosives of Concern Removal with Risk Management

Alternative 4 would include the removal of surface MEC from a 10-acre area located in the southern portion of the MRS. The 10-acre area includes a trail, the RWE, and Redoubt No. 7. The trail is maintained by the Constitution Island Caretaker and used by recreational users to visit the RWE and Redoubt No.7. The partial surface MEC removal would be followed by the implementation of LUCs (e.g., administrative mechanisms and educational controls). The LUCs would be implemented to reduce human receptor exposure to the explosive hazards posed by subsurface MEC potentially located at the 10-acre area and to the explosive hazards posed by

[2] *Total costs may vary from supporting estimates due to rounding.*

surface/subsurface MEC potentially located within the remaining 42 acres of the MRS. The location of the 10-acre area and the extent of the partial surface MEC removal are presented in **Figure 4-3**. The components of the alternative are discussed in detail below.

Because this alternative would result in MEC remaining at the MRS, Five-Year Reviews would be performed no less often than every five years after initiation of the remedial action until the MRS qualifies for UU/UE. Five-Year Reviews would include the following general steps:

- Existing documentation review.
- New information and current site conditions review and identification.
- Five-Year Review report preparation.

4.5.1 Surface Munitions and Explosives of Concern Removal Component

The surface MEC removal would be conducted within only the 10-acre area, and no surface/subsurface MEC removal would be conducted in the remaining 42 acres. The following general activities would be conducted for the surface MEC removal component of this alternative: planning document preparation, vegetation removal, and surface MEC removal.

The following planning documents would be prepared for this alternative: work plan, accident prevention plan/site safety and health plan, uniform federal policy–quality assurance project plan, and ESS. Vegetation removal at the 10-acre area would follow planning document preparation.

In preparation for vegetation removal, an exclusion zone would be established to prohibit unauthorized access. Access to the 10-acre area would be restricted via land by utilizing construction barriers, caution tape, and warning signs installed around the perimeter of the exclusion zone. Access to the MRS would be restricted via water by performing patrols in the Hudson River to prevent boater access. As previously indicated, the exclusion zone would be based on the 3-inch Stokes mortar and an HFD of 219 feet. The exclusion zone for Alternative 4 is presented in **Figure 4-3**. The Constitution Island Caretaker/recreationists and non-essential personnel would be prevented from entering the exclusion zone during alternative implementation.

Vegetation removal would be performed with hand tools and focus on the removal of brush/undergrowth and trees with a diameter of 2 inches or less from the 10-acre area. The vegetation removal team would be assisted by a DDESB TP-18 qualified individual to conduct UXO avoidance activities using a handheld magnetometer (e.g., optically pumped, flux-gate, or FDEMI). Removed vegetation would be mulched, temporarily stored on-site in an area previously cleared of MEC, and trucked off-site for use by West Point. The surface MEC removal would follow vegetation removal.

During the surface MEC removal, all surface anomalies would be identified and managed according to an approved ESS, EM 385-1-97/DoDM 6055.09M. The surface MEC removal team would be composed of DDESB TP-18–qualified personnel. For the surface MEC removal, a state licensed surveyor would establish a control point and the surface MEC removal team would subdivide the MRS into 100-foot by 100-foot grids with each grid containing no less than 20

parallel lanes. Each lane would be swept using a handheld magnetometer (e.g., optically pumped, flux-gate, or FDEMI) to identify surface anomalies. Anomalies would be identified and managed according to an approved ESS, EM 385-1-97/DoDM 6055.09M.

MPPEH or MDEH identified during vegetation removal and/or the handheld magnetometer assisted visual survey would be BIP or disposed by consolidated shot. The item would only be disposed by consolidated shot if SUXOS and UXOSO agree that the item is acceptable to move. The item determined to be acceptable to move must remain in the grid found. If disposal operations (i.e., BIP or consolidated shot) are conducted, then exclusion zones and engineering controls would be utilized to minimize explosive hazards; exclusion zone establishment would use the same methods described above to prohibit access to the 10-acre area. Disposal operations would follow EM 385-1-97 and an approved ESS.

Geophysical system verification would be conducted to evaluate detection instrument response and determine which MEC detection technology process options (e.g., optically pumped, flux-gate, or FDEMI) should be utilized to ensure that data quality objectives are achieved. It should be noted that previously identified MEC was found on the ground surface (3-inch Stokes mortar) and MD (3-inch Stokes mortar related and unidentified munitions) was detected from one inch to eight inches bgs at the MRS.

The provisions of *Standard Operating Procedure 16-1: Protection of Archaeological or Historical Artifacts* would be followed to mitigate cultural resources damage during implementation of this alternative. These cultural resources are located near and within the 10-acre area. These provisions would include stopping work and notifying the Cultural Resource Office when a suspected artifact is found (USMA, 1995).

4.5.2 Risk Management Component

The risk management component of this alternative would implement LUCs to reduce human receptor exposure to the explosive hazards posed by MEC within all 52 acres of the MRS (**Figure 4-3**). These LUCs would include the administrative mechanisms and educational controls detailed in the Institutional Analysis (**Appendix B**). A LUCP would be prepared to detail LUC implementation at the MRS.

The following LUC technology process options would be implemented at the MRS:

- Land Use Restrictions—Use of the MRS for residential purposes, daycare facilities, hospitals, or schools would be prohibited without prior approval from West Point.
- Master Plan Notation—The installation master plan would include a notation requiring a record of all 911 calls involving MEC in a geographic information system database to facilitate explosive hazard delineation.
- Dig Permits—Dig permits and construction support would be required whenever ground is broken at the MRS. There is a moderate to high probability of encountering MEC at the MRS; therefore, on-site construction support according to the *Probability Assessment for*

Determining the Probability of Encountering MEC would be required when intrusive activities are performed (West Point, 2016).

- Public Advisories—Brochures (e.g., 3Rs pamphlet) detailing the potential dangers of MEC would be developed and provided to the Constitution Island Caretaker and the recreationists visiting the RWE and Redoubt No. 7.
- Annual Review—LUCs will be reviewed annually by West Point.

In the event that a suspected munition is discovered by the Constitution Island Caretaker, recreational user, or contractor personnel, the location of the suspected munition would be marked and installation officials notified (i.e., 3Rs protocol). Installation officials would assume control and security of the item until such time as the responding EOD team arrived on site. The responding EOD team would dispose and/or remove the item in accordance with current EOD procedures.

4.5.3 Screening of Alternative 4

- Effectiveness: This alternative would be protective of human receptors by removing surface MEC from the 10-acre area and implementing LUCs to reduce human receptor exposure to the explosive hazards posed by potential subsurface MEC located at all of the MRS. This alternative would reduce the TMV of MEC at the MRS but would not satisfy the statutory preference for treatment as a principal element of the selected remedy. The use of DDESB TP-18–qualified personnel for MEC disposal would reduce the short-term effects of alternative implementation. Workers and the Constitution Island Caretaker/recreationists would also be exposed to explosive hazards during vegetation removal activities. This alternative would comply with the substantive requirements of 40 CFR 264.601 (Environmental Performance Standards) by utilizing exclusion zones, engineering controls, and DDESB TP-18–qualified personnel when performing a consolidated shot. This alternative would require approximately one year to employ to reduce human receptor exposure to the explosive hazards posed by MEC located at the MRS.
- Implementability: The LUCs included in this alternative would be technically and administratively feasible because similar LUCs were implemented on an interim basis by West Point, and West Point approved of their use in the past. The technology and equipment required for vegetation and surface MEC removal can be reliably operated with readily available equipment and skilled workers. The implementation of this alternative, to remove a likely low number of MEC, could destroy historical artifacts and reduce the educational value of Constitution Island (a specially managed site). Constitution Island and the 10-acre area contain sensitive and very well-preserved cultural resources dating back to the Revolutionary War.

- Cost[3]: The total present value of this alternative would be $872,446. The total present value was derived from capital ($652,122), annual O&M ($49,967), and periodic ($242,992) costs based on a discount rate of 1.5% over a 30-year period.

Alternative 4—Partial Surface MEC Removal with Risk Management would effectively protect human receptors from the explosive hazards posed by MEC. Alternative 4 would be implementable, although implementation could reduce the educational value of Constitution Island. The costs for Alternative 4 are grossly excessive compared to its overall effectiveness because Alternative 4 would still require the implementation of LUCs following the partial surface MEC removal. The post-removal requirement of LUCs provides similar effectiveness and implementability to that of Alternative 2, but at greater cost. Therefore, Alternative 4 will not be analyzed as a potential alternative for the MRS.

4.6 Alternative 5—Partial Surface/Subsurface Munitions and Explosives of Concern Removal with Risk Management

Alternative 5 would include the removal of surface/subsurface MEC from a 10-acre area located in the southern portion of the MRS. The 10-acre area includes a trail, the RWE, and Redoubt No. 7. The trail is maintained by the Constitution Island Caretaker and used by recreational users to visit the RWE and Redoubt No.7. The partial surface/subsurface MEC removal would be followed by the implementation of LUCs (e.g., administrative mechanisms and educational controls). The LUCs would be implemented to reduce human receptor exposure to the explosive hazards posed by surface/subsurface MEC at the remaining 42 acres of the MRS. The location of the 10-acre area and the extent of the partial surface/subsurface MEC removal are presented in **Figure 4-4**. The components of the alternative are discussed in detail below.

Because this alternative would result in MEC remaining at the MRS, Five-Year Reviews would be performed no less often than every five years after initiation of the remedial action until the MRS qualifies for UU/UE. Five-Year Reviews would include the following general steps:

- Existing documentation review.
- New information and current site conditions review and identification.
- Five-Year Review report preparation.

4.6.1 Surface/Subsurface Munitions and Explosives of Concern Removal Component

The surface/subsurface MEC removal would be conducted within only the 10-acre area, and no surface/subsurface MEC removal would be conducted in the remaining 42 acres. The following general activities would be conducted for the surface/subsurface MEC removal component of this

[3] *Total costs may vary from supporting estimates due to rounding.*

alternative: planning document preparation, clearcutting and grubbing, surface MEC removal, and subsurface MEC removal.

The following planning documents would be prepared for this alternative: work plan, accident prevention plan/site safety and health plan, uniform federal policy–quality assurance project plan, ESS, and storm water pollution prevention plan. Clearcutting and grubbing of the 10-acre area would follow planning document preparation.

In preparation for clearcutting and grubbing, an exclusion zone would be established to prohibit unauthorized access. Access to the 10-acre area would be restricted via land by utilizing construction barriers, caution tape, and warning signs installed around the perimeter of the exclusion zone. Access to the MRS would be restricted via water by performing patrols in the Hudson River to prevent boater access. As previously indicated, the exclusion zone would be based on the 3-inch Stokes mortar and an HFD of 219 feet. The exclusion zone for Alternative 5 is presented in **Figure 4-4**. The Constitution Island Caretaker/recreationists and non-essential personnel would be prevented from entering the exclusion zone during alternative implementation.

Clearcutting and grubbing would be performed with hand tools and armored mechanical equipment (e.g., excavator, hydraulic axe, and/or brush hog). The clearcutting and grubbing team would be assisted by a DDESB TP-18 qualified individual to conduct UXO avoidance activities using a handheld magnetometer (e.g., optically pumped, flux-gate, or FDEMI). Cleared and grubbed vegetation would be mulched, temporarily stored on-site in an area previously cleared of MEC, and trucked off-site for use on Constitution Island by West Point. Surface MEC removal activities would follow clearcutting and grubbing.

During the surface MEC removal, all anomalies would be identified and managed according to an approved ESS, EM 385-1-97/DoDM 6055.09M. The surface MEC removal team would be composed of DDESB TP-18–qualified personnel. For the surface MEC removal, a state licensed surveyor would establish a control point and the MEC removal team would subdivide the MRS into 100-foot by 100-foot grids with each grid containing no less than 20 parallel lanes. Each lane would be surface swept using a handheld magnetometer (e.g., optically pumped, flux-gate, or FDEMI) assisted by visual survey. Subsurface MEC removal activities would follow surface removal activities.

The subsurface MEC removal would utilize both TDEMI and handheld magnetometer (e.g., optically pumped, flux-gate, or FDEMI) MEC detection technology. A handheld magnetometer would be utilized in areas of the MRS too steep or otherwise inaccessible for the use of TDEMI technology (i.e., DGM) because TDEMI technology requires the use of large, less mobile sensor systems than handheld magnetometer technology. Handheld magnetometer survey activities would be conducted by DDESB TP-18–qualified personnel utilizing hand tools (e.g., non-sparking shovels) and an appropriate positioning technology. Anomalies would be identified and managed according to an approved ESS, EM 385-1-97/DoDM 6055.09M.

DGM survey activities would be conducted by DDESB TP-18–qualified personnel utilizing an appropriate positioning technology. Data acquired during the DGM survey would be processed and analyzed to prepare an anomaly list for reacquisition and evaluation. A dig team consisting of DDESB TP-18–qualified personnel would reacquire each listed anomaly using a handheld magnetometer (e.g., optically pumped, flux-gate, or FDEMI) and hand tools (e.g., non-sparking shovels). Reacquired anomalies would be identified and managed according to an approved ESS, EM 385-1-97/DoDM 6055.09M.

MPPEH or MDEH identified during the handheld magnetometer and DGM surveys would be BIP or disposed by consolidated shot. The item would only be disposed by consolidated shot if SUXOS and UXOSO agree that the item is acceptable to move. The item determined to be acceptable to move must remain in the grid found. If disposal operations (i.e., BIP or consolidated shot) are conducted, then exclusion zones and engineering controls would be utilized to minimize explosive hazards; exclusion zone establishment would use the same methods described above to prohibit access to the 10-acre area via land and water. Disposal operations would follow EM 385-1-97 and an approved ESS.

Geophysical system verification would be conducted to evaluate detection instrument response and determine which combination of MEC detection technology process options (e.g., optically pumped, flux-gate, FDEMI, or TDEMI) should be utilized to ensure that data quality objectives are achieved. It should be noted that previously identified MEC was found on the ground surface (3-inch Stokes mortar) and MD (3-inch Stokes mortar related and unidentified munitions) was detected from one inch to eight inches bgs at the MRS. The identified munitions would be detected to a depth equivalent to 11 times their diameter or 2.8 feet below ground surface (3-inch Stokes mortar). The MEC removal would be conducted in lifts to ensure that all MEC is identified and removed from the 10-acre area.

The provisions of *Standard Operating Procedure 16-1: Protection of Archaeological or Historical Artifacts* would be followed to mitigate cultural resources damage during implementation of this alternative. These cultural resources are located near and within the 10-acre area. These provisions would include stopping work and notifying the Cultural Resource Office when a suspected artifact is found (USMA, 1995).

4.6.2 Risk Management Component

The risk management component of this alternative would implement LUCs to reduce human receptor exposure to the explosive hazards posed by MEC within the 42-acre northern portion of the MRS (**Figure 4-4**). These LUCs would include the administrative mechanisms and educational controls detailed in the Institutional Analysis (**Appendix B**). A LUCP would be prepared to detail LUC implementation at the MRS.

The following LUC technology process options would be implemented at the 42-acre northern portion of the MRS:

- Land Use Restrictions—Use of the MRS for residential purposes, daycare facilities, hospitals, or schools would be prohibited without prior approval from West Point.
- Master Plan Notation—The installation master plan would include a notation requiring a record of all 911 calls involving MEC in a geographic information system database to facilitate explosive hazard delineation.
- Dig Permits—Dig permits and construction support would be required whenever ground is broken at the MRS. There is a moderate to high probability of encountering MEC at the MRS; therefore, worker on-site construction support according to the *Probability Assessment for Determining the Probability of Encountering MEC* would be required when intrusive activities are performed (West Point, 2016).
- Public Advisories—Brochures (e.g., 3Rs pamphlet) detailing the potential dangers of MEC would be developed and provided to the Constitution Island Caretaker and the recreationists visiting the RWE and Redoubt No. 7.
- Annual Review—LUCs will be reviewed annually by West Point.

In the event that a suspected munition is discovered by the Constitution Island Caretaker, recreational user, or contractor personnel, the location of the suspected munition would be marked and installation officials notified (i.e., 3Rs protocol). Installation officials would assume control and security of the item until such time as the responding EOD team arrived on site. The responding EOD team would dispose and/or remove the item in accordance with current EOD procedures.

4.6.3 Screening of Alternative 5

- Effectiveness: This alternative would be protective of human receptors by removing surface/subsurface MEC from the 10-acre area and implementing LUCs to reduce human receptor exposure to the explosive hazards posed by surface/subsurface MEC located at the remaining 42 acres of the MRS. This alternative would reduce the TMV of MEC at the MRS but would not satisfy the statutory preference for treatment as a principal element of the selected remedy. The use of DDESB TP-18–qualified personnel for MEC disposal would reduce the short-term effects of alternative implementation. The need to clearcut the 10-acre area would likely degrade the woodland ecosystem and the cultural resources present in that area of the MRS. It may take several years for trees to re-establish themselves after clearcutting, and the clearcutting of the woodland ecosystem would accelerate soil erosion. Adverse effects caused by soil erosion would be mitigated through the development and implementation of a storm water pollution prevention plan. Workers and the Constitution Island Caretaker/recreationists would also be exposed to explosive hazards during removal activities as well as the hazards (e.g., heavy equipment operation) associated with clearcutting and grubbing. The use of DDESB TP-18–qualified personnel for MEC disposal would reduce the short-term effects of alternative implementation. This alternative would comply with the substantive requirements of 40 CFR 264.601

(Environmental Performance Standards) by utilizing exclusion zones, engineering controls, and DDESB TP-18–qualified personnel when performing a consolidated shot. This alternative would require approximately one year to employ to reduce human receptor exposure to the explosive hazards posed by MEC located at the MRS.

- Implementability: The LUCs included in this alternative would be technically and administratively feasible because similar LUCs were implemented on an interim basis by West Point, and West Point approved of their use in the past. The technology, equipment, and skilled workers required for MEC removal are readily available; however, the technical feasibility of clearcutting and grubbing would be limited by the ability to maneuver and operate heavy equipment on the MRS where steep terrain and steep cliffs are present. Clearcutting and grubbing the 10-acre area, to remove a likely low number of MEC, would denude the entire 10-acre area of vegetation and destroy historical artifacts, thereby reducing the aesthetic and educational value of Constitution Island (a specially managed site). Constitution Island and the 10-acre area contain sensitive and very well-preserved cultural resources dating back to the Revolutionary War.
- Cost[4]: The total present value of this alternative would be $1,061,639. The total present value was derived from capital ($841,315), annual O&M ($49,967), and periodic ($242,992) costs based on a discount rate of 1.5% over a 30-year period.

Alternative 5—Partial Surface/Subsurface MEC Removal with Risk Management would effectively protect human receptors from the explosive hazards posed by MEC. Alternative 5 would be implementable, although implementation would reduce the aesthetic and educational value of Constitution Island. The costs for Alternative 5 would not be grossly excessive compared to its overall effectiveness. Therefore, Alternative 5 will be analyzed as a potential alternative for the MRS.

4.7 Alternative 6—Surface Munitions and Explosives of Concern Removal with Risk Management

Alternative 6 would include removal of only surface MEC from all 52 acres of the MRS. The surface MEC removal would be followed by the implementation of LUCs (e.g., administrative mechanisms and educational controls) to reduce human receptor exposure to the explosive hazards posed by subsurface MEC located at the MRS. The extent of the surface MEC removal are presented in **Figure 4-5**. The components of the alternative are discussed in detail below.

Because this alternative would result in MEC remaining at the MRS, Five-Year Reviews would be performed no less often than every five years after initiation of the remedial action until the MRS qualifies for UU/UE. Five-Year Reviews would include the following general steps:

[4] *Total costs may vary from supporting estimates due to rounding.*

- Existing documentation review.
- New information and current site conditions review and identification.
- Five-Year Review report preparation.

4.7.1 Surface Munitions and Explosives of Concern Removal Component

The surface MEC removal would be conducted within all of the MRS, but no subsurface MEC removal would be conducted in any of the MRS. The following general activities would be conducted for the surface MEC removal component of this alternative: planning document preparation, vegetation removal, and surface MEC removal.

The following planning documents would be prepared for this alternative: work plan, accident prevention plan/site safety and health plan, ecological resources plan, uniform federal policy–quality assurance project plan, and ESS. Vegetation removal at the MRS would follow planning document preparation.

In preparation for vegetation removal, an exclusion zone would be established to prohibit unauthorized access. Access to the MRS would be restricted via land by utilizing construction barriers, caution tape, and warning signs installed around the perimeter of the exclusion zone. Access to the MRS would be restricted via water by performing patrols in the Hudson River to prevent boater access. As previously indicated, the exclusion zone would be based on the 3-inch Stokes mortar and an HFD of 219 feet. The exclusion zone for Alternative 6 is presented in **Figure 4-5**. The Constitution Island Caretaker/recreationists and non-essential personnel would be prevented from entering the exclusion zone during alternative implementation.

Vegetation removal would be performed with hand tools and focus on the removal of brush/undergrowth and trees with a diameter of 2 inches or less from the MRS. The vegetation removal team would be assisted by a DDESB TP-18 qualified individual to conduct UXO avoidance activities using a handheld magnetometer (e.g., optically pumped, flux-gate, or FDEMI). Removed vegetation would be mulched, temporarily stored on-site in an area previously cleared of MEC, and trucked off-site for use by West Point. The surface MEC removal would follow vegetation removal.

During the surface MEC removal, surface anomalies would be identified and managed according to an approved ESS, EM 385-1-97/DoDM 6055.09M. The surface MEC removal team would be composed of DDESB TP-18–qualified personnel. For the surface MEC removal, a state licensed surveyor would establish several control points and the surface MEC removal team would subdivide the MRS into 100-foot by 100-foot grids with each grid containing no less than 20 parallel lanes. Each lane would be swept using a handheld magnetometer (e.g., optically pumped, flux-gate, or FDEMI) to identify surface anomalies. Anomalies would be identified and managed according to an approved ESS, EM 385-1-97/DoDM 6055.09M.

MPPEH or MDEH identified during vegetation removal and/or the handheld magnetometer assisted visual survey would be BIP or disposed by consolidated shot. The item would only be

disposed by consolidated shot if SUXOS and UXOSO agree that the item is acceptable to move. The item determined to be acceptable to move must remain in the grid found. If disposal operations (i.e., BIP or consolidated shot) are conducted, then exclusion zones and engineering controls would be utilized to minimize explosive hazards; exclusion zone establishment would use the same methods described above to prohibit access to the MRS. Disposal operations would follow EM 385-1-97 and an approved ESS.

Geophysical system verification would be conducted to evaluate detection instrument response and determine which MEC detection technology process options (e.g., optically pumped, flux-gate, or FDEMI) should be utilized to ensure that data quality objectives are achieved. It should be noted that previously identified MEC was found on the ground surface (3-inch Stokes mortar) and MD (3-inch Stokes mortar related and unidentified munitions) was detected from one inch to eight inches bgs at the MRS.

The provisions of *Standard Operating Procedure 16-1: Protection of Archaeological or Historical Artifacts* would be followed to mitigate cultural resources damage during implementation of this alternative. These cultural resources are located near and within the MRS. These provisions would include stopping work and notifying the Cultural Resource Office when a suspected artifact is found (USMA, 1995).

The provisions of the ecological resources plan would also be followed to mitigate ecological resources damage during implementation of this alternative. These ecological resources consist of four wetland areas totaling 2.24 acres located within the MRS (**Figure 1-5**). These provisions would include the preparation of an ecological field survey to evaluate the area in which the alternative would be conducted as well as procedures to be followed to mitigate ecological resources damage. The ecological resources plan would be prepared in accordance with EM 200-1-15 (USACE, 2013).

4.7.2 Risk Management Component

The risk management component of this alternative would implement LUCs to reduce human receptor exposure to the explosive hazards posed by MEC within all 52 acres of the MRS (**Figure 4-5**). These LUCs would include the administrative mechanisms and educational controls detailed in the Institutional Analysis (**Appendix B**). A LUCP would be prepared to detail LUC implementation at the MRS.

The following LUC technology process options would be implemented at the MRS:

- Land Use Restrictions—Use of the MRS for residential purposes, daycare facilities, hospitals, or schools would be prohibited without prior approval from West Point.
- Master Plan Notation—The installation master plan would include a notation requiring a record of all 911 calls involving MEC in a geographic information system database to facilitate explosive hazard delineation.

- Dig Permits—Dig permits and construction support would be required whenever ground is broken at the MRS. There is a moderate to high probability of encountering MEC at the MRS; therefore, on-site construction support according to the *Probability Assessment for Determining the Probability of Encountering MEC* would be required when intrusive activities are performed (West Point, 2016).
- Public Advisories—Brochures (e.g., 3Rs pamphlet) detailing the potential dangers of MEC would be developed and provided to the Constitution Island Caretaker and the recreationists visiting the RWE and Redoubt No. 7.
- Annual Review—LUCs will be reviewed annually by West Point.

In the event that a suspected munition is discovered by the Constitution Island Caretaker, recreational user, or contractor personnel, the location of the suspected munition would be marked and installation officials notified (i.e., 3Rs protocol). Installation officials would assume control and security of the item until such time as the responding EOD team arrived on site. The responding EOD team would dispose and/or remove the item in accordance with current EOD procedures.

4.7.3 Screening of Alternative 6

- Effectiveness: This alternative would be protective of human receptors by removing surface MEC from all of the MRS and implementing LUCs to reduce human receptor exposure to the explosive hazards posed by subsurface MEC located at all of the MRS. This alternative would reduce the TMV of MEC at the MRS and satisfy the statutory preference for treatment as a principal element of the selected remedy. The use of DDESB TP-18–qualified personnel for MEC disposal would reduce the short-term effects of alternative implementation. Workers and the Constitution Island Caretaker/recreationists would also be exposed to explosive hazards during vegetation removal activities. The need to remove MEC from the MRS may adversely affect wetlands located within the MRS. The adverse effects caused by MEC removal would be mitigated through the development and implementation of an ecological resources plan. This alternative would comply with the substantive requirements of 40 CFR 264.601 (Environmental Performance Standards) by utilizing exclusion zones, engineering controls, and DDESB TP-18–qualified personnel when performing a consolidated shot. This alternative would require approximately one year to employ to reduce human receptor exposure to the explosive hazards posed by MEC located at the MRS.
- Implementability: The LUCs included in this alternative would be technically and administratively feasible because similar LUCs were implemented on an interim basis by West Point, and West Point approved of their use in the past. The technology and equipment required for vegetation and surface MEC removal can be reliably operated with readily available equipment and skilled workers. The implementation of this alternative, to remove a likely low number of MEC, could destroy historical artifacts and reduce the

educational value of Constitution Island (a specially managed site). Constitution Island and the 10-acre area contain sensitive and very well-preserved cultural resources dating back to the Revolutionary War.

- Cost[5]: The total present value of this alternative would be $2,151,349. The total present value was derived from capital ($2,015,720), annual O&M ($49,967), and periodic ($242,992) costs based on a discount rate of 1.5% over a 30-year period.

Alternative 6—Surface MEC Removal with Risk Management would effectively protect human receptors from the explosive hazards posed by MEC. Alternative 6 would be implementable, although implementation could reduce the educational value of Constitution Island. The costs for Alternative 6 would be grossly excessive compared to its overall effectiveness because Alternative 6 would still require the implementation of LUCs following the surface MEC removal. Therefore, Alternative 6 will not be analyzed as a potential alternative for the MRS.

[5] *Total costs may vary from supporting estimates due to rounding.*

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5.0 DETAILED ANALYSIS OF ALTERNATIVES

This section provides a detailed analysis of the remedial alternatives developed and selected for further evaluation in Section 4. This assessment consists of evaluating each alternative using seven of the nine criteria listed in the NCP. The remaining two criteria, state and community acceptance, will be evaluated following the Proposed Plan public comment period. The cost estimates are preliminary and based on currently available data. The cost estimates developed for this FS are expected to provide an accuracy of +50% to –30% based on available data and engineering judgment (EPA, 1988). The purpose of this detailed evaluation of alternatives is to provide performance and cost data that may be used to evaluate further remedial actions at the MRS.

5.1 Evaluation Criteria

Evaluation criteria are described in the NCP, 40 CFR Section 300.430(e)(9). The criteria were developed to address the CERCLA requirements and considerations, and to address the additional technical and policy considerations that are important in selecting remedial alternatives. These evaluation criteria serve as the basis for conducting the detailed analyses during the FS and for selecting an appropriate remedial action. The evaluation criteria with the associated statutory considerations are described below.

The MEC HA conducted for the remedial alternatives and presented in **Appendix A** provides useful information for several of the nine evaluation criteria, including: the protection of human health and the environment, compliance with ARARs, long-term effectiveness, short-term effectiveness, implementability, and treatment to reduce the TMV of MEC. The inputs and outputs of the MEC HA are used qualitatively in the detailed analysis of alternatives.

The "threshold criteria" are requirements that each alternative must meet or have specifically waived to be eligible for selection. As stated in the *Final United States Army Military Munitions Response Program Munitions Response Remedial Investigation/Feasibility Study Guidance*, in the absence of thresholds for MEC, the primary objective of the response is to reduce hazards while meeting ARARs. The threshold criteria that each alternative must meet, as described in the NCP, include:

1. **Overall Protectiveness of Human Health and the Environment**—Assesses whether the alternatives can adequately protect human health and the environment, in both the short and long term, from the explosive hazards present at the MRS by eliminating, reducing, or controlling exposures to MEC. Overall protection of human health and the environment draws on the assessment of other evaluation criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs.
2. **Compliance with ARARs**—Evaluates whether the alternative complies with MRS-specific ARARs or whether a waiver is justified. MRS-specific ARARs are summarized in Section 2.

The five "balancing criteria" described below are those that form the basis for comparison among alternatives that meet the threshold criteria. The balancing criteria are weighed against each other to determine which remedies are cost effective and are "permanent" to the maximum extent practicable:

3. **Long-Term Effectiveness and Permanence**—Considers the magnitude of residual hazard remaining at the conclusion of remedial activities and the adequacy and reliability of the response in managing any treatment residuals and untreated waste.
4. **Reduction of TMV of Contaminants through Treatment**—Assesses the degree to which response alternatives employ recycling or treatment that reduces the TMV of MEC. Remedial alternatives, at a minimum, address the principal potential threats posed by the MRS to the local environment. Considerations in the evaluation of this criterion may include:
    - Disposal processes for MEC.
    - Amount of MEC to be destroyed, treated, or recycled. Management of MPPEH, and the disposal of MDEH or MDAS.
    - Degree of expected reduction in TMV, including the means by which the principal threat is addressed.
    - Degree to which the alternative is irreversible.
    - Type, quantity, or volume of residuals that will remain, considering persistence, toxicity, and mobility.
    - The degree to which an alternative reduces the inherent hazards posed by the principal threats (U.S. Army, 2009).
5. **Short-Term Effectiveness**—Considers worker and community safety as well as ecological, socioeconomic, and cultural impacts during implementation of the alternative. Also considers the effectiveness and reliability of the protective measures employed and the time until protection is achieved. The evaluation of socioeconomic impacts addresses if environmental justice is a concern or potential concern.
6. **Implementability**—Considers the technical and administrative feasibility of implementing the alternative and includes, as appropriate, the following factors:
    - Technical requirements:
        - Access due to terrain, vegetation, soils, water, or hazards;
        - Availability of technology;
        - Availability of equipment;
        - Available technology; and

- Ability to determine effectiveness.

- Administrative requirements:
  - Ability to obtain approvals;
  - Coordination and time requirements;
  - Access due to ownership;
  - Personnel/equipment shortages; and
  - Funding availability.

7. **Cost**—This balancing criterion is used to evaluate the capital cost, annual O&M cost, periodic cost, and the total present value associated with implementing each alternative and considers a discount rate of 1.5% over a 30-year period. The 30-year period does not place a limitation on the length of the response but is used during the comparative analysis to evaluate the cost differences among the alternatives. Cost estimates for each alternative have a desired accuracy of +50% to –30% (EPA, 1988).

The last two criteria, the "modifying criteria," will be fully evaluated following receipt of stakeholder and regulatory comments on the FS and community review of and comment on the Proposed Plan. Public comment on the Proposed Plan is addressed in the Decision Document:

8. **Regulatory Agency Acceptance**—Assesses the technical and administrative issues and concerns the state (New York State Department of Environmental Conservation [NYSDEC]) and EPA Region II may have regarding each of the alternatives evaluated in the FS, as well as the preferred alternative presented in the Proposed Plan. State and EPA acceptance of an alternative will be evaluated after the Proposed Plan is issued for public comment. Therefore, the regulatory acceptance criterion is not addressed in the FS.

9. **Community Acceptance**—Assesses the issues and concerns the public may have regarding each of the alternatives evaluated in the FS, as well as the preferred alternative presented in the Proposed Plan. Community acceptance of an alternative will be evaluated after the Proposed Plan is issued for public comment. Therefore, the community acceptance criterion is not addressed in the FS.

5.2 Individual Analysis of Alternatives

The following remedial alternatives are evaluated for the MRS against each of the NCP criteria except for regulatory agency and community acceptance in this section:

- Alternative 1—No Action;
- Alternative 2—Risk Management; and
- Alternative 5—Partial Surface/Subsurface MEC Removal with Risk Management.

5.2.1 Alternative 1—No Action

Alternative 1 is evaluated against each of the NCP criteria except for regulatory agency and community acceptance in the following bullets:

1. **Overall Protectiveness of Human Health and the Environment**—Alternative 1 would not meet the criterion for overall protectiveness of human health. No hazards to the environment are posed by residual MEC.

   The MEC HA Hazard Score/Hazard Level does not change when this alternative is selected. Therefore, this alternative would not reduce the explosive hazard posed to human receptors by MEC at the MRS. In addition, this alternative would not be effective in the long-term because MEC would remain at the MRS and access to the MRS would not be restricted. In the short term, there would be no additional risks to workers or the Constitution Island Caretaker/recreationists.

2. **Compliance with ARARs**—There would be no ARARs associated with this alternative because no action would be taken with this alternative.

3. **Long-Term Effectiveness and Permanence**—Alternative 1 would not be effective or permanent in the long term because no action would be taken to address the explosive hazards posed by the presence of MEC. The magnitude of residual hazards caused by potential MEC would not be reduced. MEC exposure would potentially increase over time due to the action of erosion which could move MEC potentially present in the subsurface to the surface. This alternative would require no technical components and would pose no uncertainties regarding its performance.

4. **Reduction of TMV of Contaminants Through Treatment**—Alternative 1 would not reduce the TMV of MEC because no action would be taken to address the MEC present at the MRS. Alternative 1 does not satisfy the statutory preference for employing treatment as a principal element.

5. **Short-Term Effectiveness**—There would be no additional risk to workers, the Constitution Island Caretaker/recreationists, the environment, or cultural resources above those posed by the MEC present because no action would be taken. There would be no adverse socioeconomic effects resulting from the implementation of this alternative. This alternative would require no time to employ.

6. **Implementability**—This alternative would be technically and administratively feasible because it would include no action.

7. **Cost**—Alternative 1 would require no action; therefore, the total present value to perform this alternative would be $0.

5.2.2 Alternative 2—Risk Management

Alternative 2—Risk Management is evaluated against each of the NCP criteria except for regulatory agency and community acceptance in the following bullets:

1. **Overall Protectiveness of Human Health and the Environment**—Alternative 2 would meet the criterion for overall protectiveness of human health. No hazards to the environment are posed by residual MEC.

   The MEC HA Hazard Score/Hazard Level would not change if this alternative is selected. However, the LUCs that would be implemented with selection of this alternative would reduce human receptor exposure to the explosive hazards posed by MEC located at the MRS. This alternative would only be effective and permanent in the long-term if West Point continues to support and enforce LUCs.

   Specific activities and actions that would be implemented by each LUC to reduce human receptor exposure to explosive hazards are detailed in the following bullets:

   - The preparation and dissemination of public advisories (e.g., 3Rs pamphlet) would educate the Constitution Island Caretaker and recreationists on the presence of potential munitions and provide instructions on what to do if suspected munitions are encountered.
   - The tracking of 911 calls regarding the identification of munitions in a master plan would identify locations where explosive hazards are present. The tracking data may be recorded by West Point and used in a public advisory to educate the Constitution Island Caretaker/recreationists and workers on the presence of potential munitions and provide instructions on what to do if suspected munitions are encountered.
   - On-site construction support is required when conducting intrusive activities at the MRS. The on-site construction support would be conducted by specially trained personnel who are equipped to properly handle and dispose of explosive hazards.
   - Land use restrictions would prevent future incompatible development and reduce contact hours and exposure pathways.
   - An annual review would provide West Point with an opportunity to collect periodic data for use during the Five-Year Review to evaluate and ensure the LUC program remains protective.

   In addition, while Alternative 2 would not satisfy the statutory preference for employing treatment as a principal element, any discovered MEC would be treated by BIP or disposed of by consolidated shot using EOD personnel. A consolidated shot would only be conducted if EOD personnel determines that the MEC is acceptable to move. Consolidated shot activities would be conducted in compliance with the substantive requirements of 40

CFR 264.601 (Environmental Performance Standards) to minimize short-term effects resulting from worker exposure to the explosive hazards associated with MEC removal.

2. **Compliance with ARARs**—If discovered MEC results in disposal by consolidated shot, then compliance with the substantive requirements of 40 CFR 264.401 (Environmental Performance Standards) would be achieved by using exclusion zones, engineering controls, and EOD personnel during MEC disposal.

3. **Long-Term Effectiveness and Permanence**—Alternative 2 would provide long-term effectiveness and permanence as long as the LUCs remain in place. Remaining hazards to human receptors due to direct contact with residual MEC are mitigated by LUCs. Any MEC removed from the MRS is permanently removed. The long-term effectiveness and permanence of this alternative would require continued enforcement and support of LUCs by West Point. As discussed in the IA (**Appendix B**), the LUCs included in this alternative would be supported by West Point.

   Because this alternative would result in MEC remaining at the MRS, Five-Year Reviews would be performed as required by CERCLA until the MRS qualifies for UU/UE (i.e., negligible probability) to verify that this alternative remains protective.

4. **Reduction of TMV of Contaminants through Treatment**—Alternative 2 would not intentionally reduce the TMV of MEC at the MRS. However, the TMV of MEC would be irreversibly reduced when MEC is discovered and BIP or disposed of by consolidated shot. Alternative 2 does not satisfy the statutory preference for employing treatment as a principal element.

5. **Short-Term Effectiveness**—There would be no additional risk to workers, the Constitution Island Caretaker/recreationists, the environment, or cultural resources at the MRS due to construction or other land-disturbance activities because no such activities are associated with this alternative. The short-term hazards associated with any future construction or land-disturbance activity would be mitigated through the use of on-call construction support. Workers and the Constitution Island Caretaker/recreationists would be exposed to explosive hazards during MEC removal when MEC is discovered. These hazards would be mitigated by utilizing EOD personnel and engineering controls and establishing exclusion zones around the work area. MEC disposal operations could also negatively affect the cultural resources located within the boundaries of the MRS. However, the use of engineering controls (e.g., sand bags) during BIP or consolidated shot disposal would be utilized to prevent or reduce potential adverse effects to cultural resources. There would be no adverse socioeconomic effects resulting from the implementation of this alternative. This alternative would require approximately six months to employ to reduce human receptor exposure to the explosive hazards posed by MEC located at the MRS.

The guidelines established in SOP 16-1 for protection and preservation of archaeological and historical artifacts, would be followed at all times during MEC recovery and on-site disposal. EOD personnel would be familiar with the requirements of SOP 16-1, including stop work and notification procedures.

6. **Implementability**—This alternative would be technically feasible because the required technology (e.g., on-call construction support, 3Rs pamphlet, and master plan) and equipment are readily available and reliably operated. The LUCs included in this alternative are also administratively feasible because West Point has the required technical expertise and approved of their implementation in the past. In addition, similar LUCs included in this alternative were successfully coordinated on an interim basis at the MRS. The effectiveness of the remedy would be monitored annually by West Point and through Five-Year Reviews.

7. **Cost**[6]—The total present value of this alternative would be $277,741. The total present value was derived from capital ($57,417), annual O&M ($49,967), and periodic ($242,992) costs based on a discount rate of 1.5% over a 30-year period. The detailed cost estimate for this alternative is provided in **Appendix C**.

5.2.3 Alternative 5—Partial Surface/Subsurface Munitions and Explosives of Concern Removal with Risk Management

Alternative 5—Partial Surface/Subsurface MEC Removal with Risk Management is evaluated against each of the NCP criteria except for regulatory agency and community acceptance in the following bullets:

1. **Overall Protectiveness of Human Health and the Environment**—Alternative 5 would meet the criterion for overall protectiveness of human health. No hazards to the environment are posed by residual MEC.

   The MEC HA Hazard Score would be reduced from 690 to 490 but the Hazard Level would not change if this alternative is selected. This alternative would be effective and permanent in the long-term only through the implementation of LUCs because the removal would only remove surface/subsurface MEC from the 10-acre area of the MRS. This alternative would only be effective and permanent in the long-term if West Point continues to support and enforce LUCs. Short-term effects (exposure to explosive hazards) to workers and the Constitution Island Caretaker/recreationists during MEC removal would be minimized by using exclusion zones, engineering controls, and DDESB TP-18–qualified personnel.

   Specific activities and actions that would be implemented by each LUC to reduce human receptor exposure to explosive hazards are detailed in the following bullets:

[6] *Total costs may vary from supporting estimates due to rounding.*

- The preparation and dissemination of public advisories (e.g., 3Rs pamphlet) would educate the Constitution Island Caretaker and recreationists on the presence of potential munitions and provide instructions on what to do if suspected munitions are encountered.
- The tracking of 911 calls regarding the identification of munitions in a master plan would identify locations where explosive hazards are present. The tracking data may be recorded by West Point and used in a public advisory to educate the Constitution Island Caretaker/recreationists and workers on the presence of potential munitions and provide instructions on what to do if suspected munitions are encountered.
- On-site construction support is required when conducting intrusive activities at the MRS. The on-site construction support would be conducted by specially trained personnel who are equipped to properly handle and dispose of explosive hazards.
- Land use restrictions would prevent future incompatible development and reduce contact hours and exposure pathways.
- An annual review would provide West Point with an opportunity to collect periodic data for use during the Five-Year Review to evaluate and ensure the LUC program remains protective.

In addition, any discovered MEC in the 42-acre northern portion of the MRS would be treated by BIP or disposed of by consolidated shot using EOD personnel. A consolidated shot would only be conducted if EOD personnel determines that the MEC is acceptable to move. Consolidated shot activities would be conducted in compliance with the substantive requirements of 40 CFR 264.601 (Environmental Performance Standards) to minimize short-term effects resulting from worker exposure to the explosive hazards associated with MEC removal.

2. **Compliance with ARARs**—If discovered MEC results in disposal by consolidated shot, then compliance with the substantive requirements of 40 CFR 264.601 (Environmental Performance Standards) would be achieved by using exclusion zones, engineering controls, and DDESB TP-18–qualified personnel during MEC disposal.
3. **Long-Term Effectiveness and Permanence**—Alternative 5 would provide long-term effectiveness and permanence as long as the LUCs remain in place. Although removal of surface/subsurface MEC from the 10-acre area, where the only current receptor activity occurs, would reduce the magnitude of the residual explosive hazard posed to human receptors by MEC. Remaining hazards to human receptors due to direct contact with residual MEC are mitigated by LUCs. Any MEC removed from the MRS is permanently removed. The long-term effectiveness and permanence of this alternative would require

continued enforcement and support of LUCs by West Point. As discussed in the IA (**Appendix B**), the LUCs included in this alternative would be supported by West Point.

Because this alternative would result in MEC remaining at the MRS, Five-Year Reviews would be performed as required by CERCLA until the MRS qualifies for UU/UE (i.e., negligible probability) to verify that this alternative remains protective.

4. **Reduction of TMV of Contaminants through Treatment**—Alternative 5 would irreversibly remove detected surface/subsurface MEC from the 10-acre area, thereby reducing the TMV associated with surface/subsurface MEC located in that area of the MRS. The TMV of MEC would not be intentionally reduced in remaining 42 acres of the MRS where LUCs are applied. However, the TMV of MEC would be irreversibly reduced where LUCs are applied when MEC is discovered and BIP or disposed of by consolidated shot. This alternative would not satisfy the statutory preference for employing treatment as a principal element.

5. **Short-Term Effectiveness**—There would be an increased risk to workers and the Constitution Island Caretaker/recreationists during the implementation of this alternative because of the hazards associated with MEC disposal (e.g., shipping donor explosive to the MRS and demolition operations) as well as clearcutting and grubbing (e.g., heavy equipment operation and potential exposure to explosive hazards). Such risks would be mitigated through the development and enforcement of work plans, the use of DDESB TP-18–qualified personnel, and the establishment of exclusion zones around the work area.

   This alternative would also negatively affect the cultural resources located near and/or within the MRS. Adverse cultural resource effects (i.e., historical artifact destruction) would be mitigated by using engineering controls (e.g., sand bags) during MEC disposal and relocating MEC deemed acceptable to move away from cultural resources for consolidated shot disposal. In addition, the guidelines established in SOP 16-1 for protection and preservation of archaeological and historical artifacts would be followed at all times during clearcutting and grubbing and MEC disposal. Workers will be familiar with the requirements of the SOP, including stop work and notification procedures.

   The need to clearcut the 10-acre area would likely degrade the woodland ecosystem and the cultural resources present in that area of the MRS. It may take several years for trees to re-establish themselves after clearcutting, and the clearcutting of the woodland ecosystem would accelerate soil erosion. Adverse effects caused by soil erosion would be mitigated through the development and implementation of a storm water pollution prevention plan.

   There would be no adverse socioeconomic effects resulting from the implementation of this alternative. This alternative would require approximately one year to employ to reduce human receptor exposure to the explosive hazards posed by MEC located at the MRS.

6. **Implementability**—Alternative 5 would be technically feasible because each technology process option would be readily available and reliably operated. The LUCs included in this alternative are also administratively feasible because West Point has the required technical expertise and approved of their implementation in the past. Implementation of this alternative, to remove a likely low number of MEC, would denude the entire 10-acre area of vegetation and destroy historical artifacts, thereby reducing the aesthetic and educational value of Constitution Island (a specially managed site). Constitution Island and the MRS contain sensitive and very well-preserved cultural resources dating back to the Revolutionary War. The implementation of this alternative would require coordination from West Point, the Constitution Island Caretaker, and the Directorate of Public Works to ensure that the public remains outside of the exclusion zone for the duration of the clearcutting and grubbing and MEC removal. In addition, similar LUCs included in this alternative were successfully coordinated on an interim basis at the MRS. The effectiveness of the remedy would be monitored annually by West Point and through Five-Year Reviews.

7. **Cost**[7]—The total present value of this alternative would be $872,446. The total present value was derived from capital ($652,122), annual O&M ($49,967), and periodic ($242,992) costs based on a discount rate of 1.5% over a 30-year period. The detailed cost estimate for this alternative is provided in **Appendix C**.

5.3 Comparative Analysis of Remedial Alternatives

Based on the detailed analysis of remedial alternatives in Section 5.2, the strengths and weaknesses of the remedial alternatives relative to one another are evaluated with respect to each of the NCP criteria except for regulatory agency and community acceptance. Alternatives 1, 2, and 5 are compared in the discussions below.

1. **Overall Protectiveness of Human Health and the Environment**—All of the alternatives, except Alternative 1, provide protection of human health. No hazards to the environment are posed by residual MEC; therefore, all three alternatives would be equally protective of the environment. Alternative 5 eliminates the explosive hazard posed to human receptors by surface/subsurface MEC at only 10 of the 52 acres of the MRS; LUCs would be relied upon to reduce the explosive hazard posed to human receptors by MEC remaining in the 42-acre northern portion of the MRS. Alternative 2 relies only on LUCs to reduce the explosive hazard posed to human receptors by MEC located in all of the MRS.

2. **Compliance with ARARs**—Alternative 2 and Alternative 5 would comply with the substantive requirements of 40 CFR 264.601 (Environmental Performance Standards) if MEC is disposed of in a consolidated shot, by establishing exclusion zones, using engineering controls, and performing MEC disposal operations with EOD- or DDESB TP-

[7] *Total costs may vary from supporting estimates due to rounding.*

18–qualified personnel. Therefore, Alternative 2 and Alternative 5 would comply with ARARs, while no ARARs are associated with Alternative 1.

3. **Long-Term Effectiveness and Permanence**—Alternative 5 would provide greater long-term effectiveness and permanence than Alternative 2 because the implementation of Alternative 5 would remove surface/subsurface MEC from the 10-acre area of the MRS. Remaining explosive hazards posed by residual MEC to human receptors would be mitigated by the LUCs contained in Alternative 2 and Alternative 5. Alternative 2 and Alternative 5 would provide long-term effectiveness and permanence as long as the LUCs remain in place. Similar LUCs currently in place on the MRS have been effective and reliable since their implementation and are expected to remain effective and reliable in the future. Because Alternative 2 and Alternative 5 would result in MEC remaining at the MRS, Five-Year Reviews would be performed as required by CERCLA. Alternative 1 would not be effective or permanent in the long term because no action would be taken to address the explosive hazards posed to human receptors by MEC located at the MRS.

4. **Reduction of TMV of Contaminants through Treatment**—Alternative 5 would reduce the TMV of MEC more than Alternative 2 because implementation of Alternative 5 would intentionally identify and irreversibly eliminate the explosive hazards associated with surface and subsurface MEC located in the 10-acre area. Alternative 1 would not reduce the TMV of MEC because no action would be taken to address the explosive hazards posed to human receptors by MEC located at the MRS.

5. **Short-Term Effectiveness**—Alternative 1 would not expose workers, the Constitution Island Caretaker/recreationists, or environmental resources to additional hazards/risks because no action would be taken to address the explosive hazards posed by MEC located at the MRS. Alternative 2 would be more effective in the short term than Alternative 5 because workers and the Constitution Island Caretaker/recreationists would only be exposed to explosive hazards when MEC is unintentionally discovered and removed from the MRS, and because Alternative 2 does not have the potential to negatively affect the ecological or cultural resources present at the MRS. Alternative 2 would also be more effective in the short term than Alternative 5 because Alternative 2 would take less time to employ.

6. **Implementability**—Alternative 1 would be most implementable because no action would be taken to address the explosive hazards posed by the presence of MEC. Alternative 2 and Alternative 5 are equally implementable with respect to the availability of technology, equipment, and skilled workers. Alternative 2 would also be more implementable than Alternative 5 because Alternative 2 requires less coordination between multiple entities. Alternative 5 would be less implementable than Alternative 2 because of the clearcutting and grubbing required to conduct MEC removal. The clearcutting and grubbing, to remove a likely low number of MEC, would denude the entire 10-acre area of vegetation and destroy historical artifacts, thereby reducing the aesthetic and educational value of

Constitution Island. The technical feasibility of clearcutting and grubbing would be limited by the ability to maneuver and operate heavy equipment on the MRS where steep terrain and steep cliffs are present.

7. **Cost**[8]—The total present value to perform each alternative is provided below:
    - Alternative 1 = $0
    - Alternative 2 = $277,741
    - Alternative 5 = $1,061,639

[8] *Total costs may vary from supporting estimates due to rounding.*

Table 5-1 Summary of Comparative Analysis of Alternatives

Screening Criterion		Alternative 1 No Action	Alternative 2 Risk Management	Alternative 5 Partial Surface/Subsurface MEC Removal with Risk Management
Threshold	Overall Protectiveness of Human Health and Environment	F	P	P
	Compliance with ARARs	P	P	P
Balancing	Long-Term Effectiveness	3	2	1
	Reduction of TMV through Treatment	3	2	1
	Short-Term Effectiveness	1	2	3
	Implementability	1	2	3
	Cost[1]	$0	$277,741	$1,061,639
Modifying[2]	Regulatory Agency Acceptance	TBD	TBD	TBD
	Community Acceptance	TBD	TBD	TBD

Notes:
ARARs Applicable or Relevant and Appropriate Requirements
MEC Munitions and Explosives Concern
TBD To-Be-Determined
TMV Toxicity, Mobility, or Volume
UU/UE Unlimited Use/Unrestricted Exposure

Threshold criterion scored as Pass (P) or Fail (F).
Balancing criterion analyses scored from 1 to 3; where a score of 3 indicates least favorable and a score of 1 indicates most favorable.
[1] Costs are detailed in **Appendix C**. Total costs may vary from supporting estimates due to rounding.
[2] The modifying criteria of regulatory agency and community acceptance are To-Be-Determined following review and input from these parties

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FIGURES

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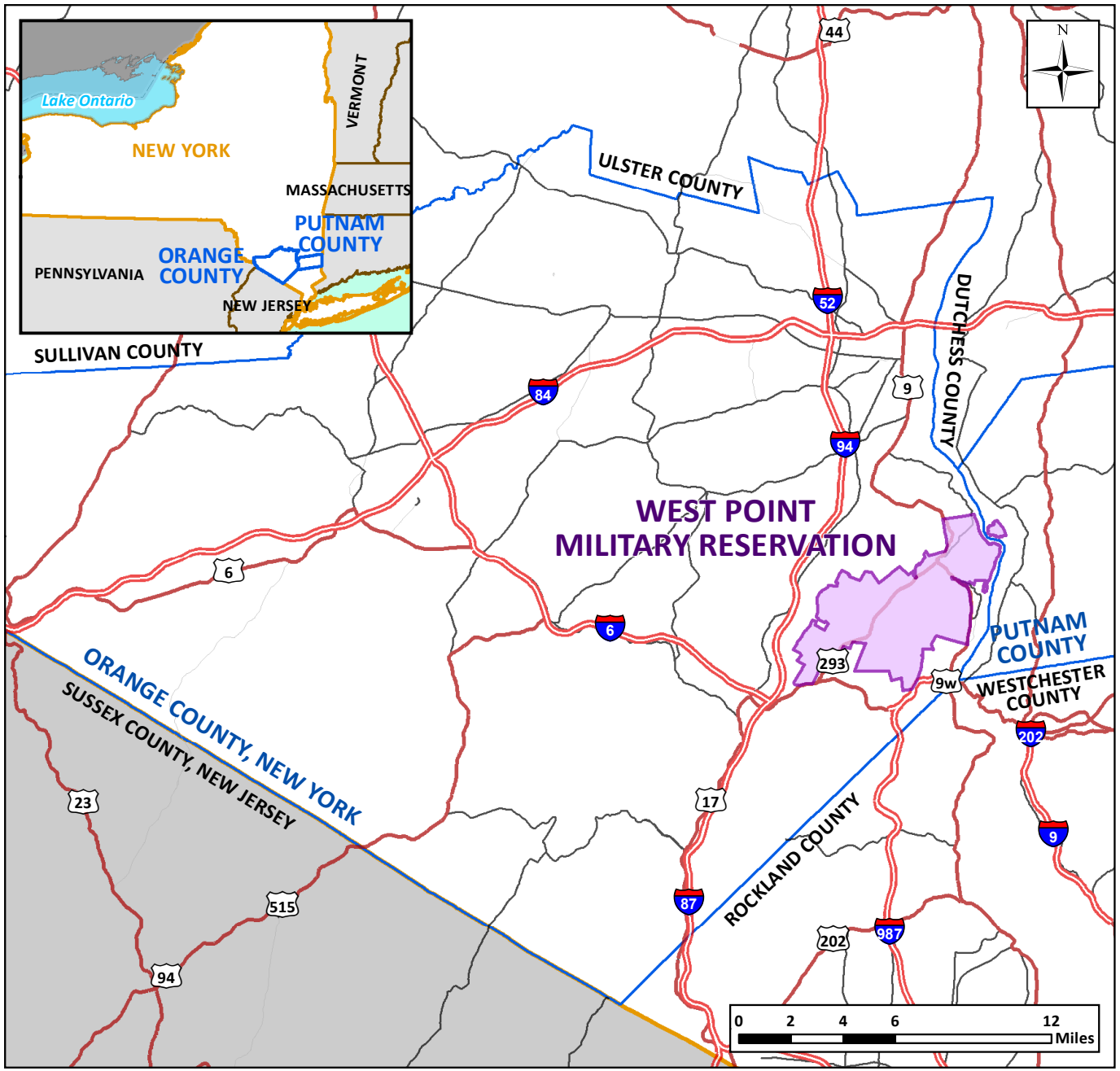

Map Key:

- State Boundary
- County Boundary
- West Point Boundary
- Lake Ontario
- Interstate
- Highway
- Major Road
- Local Road

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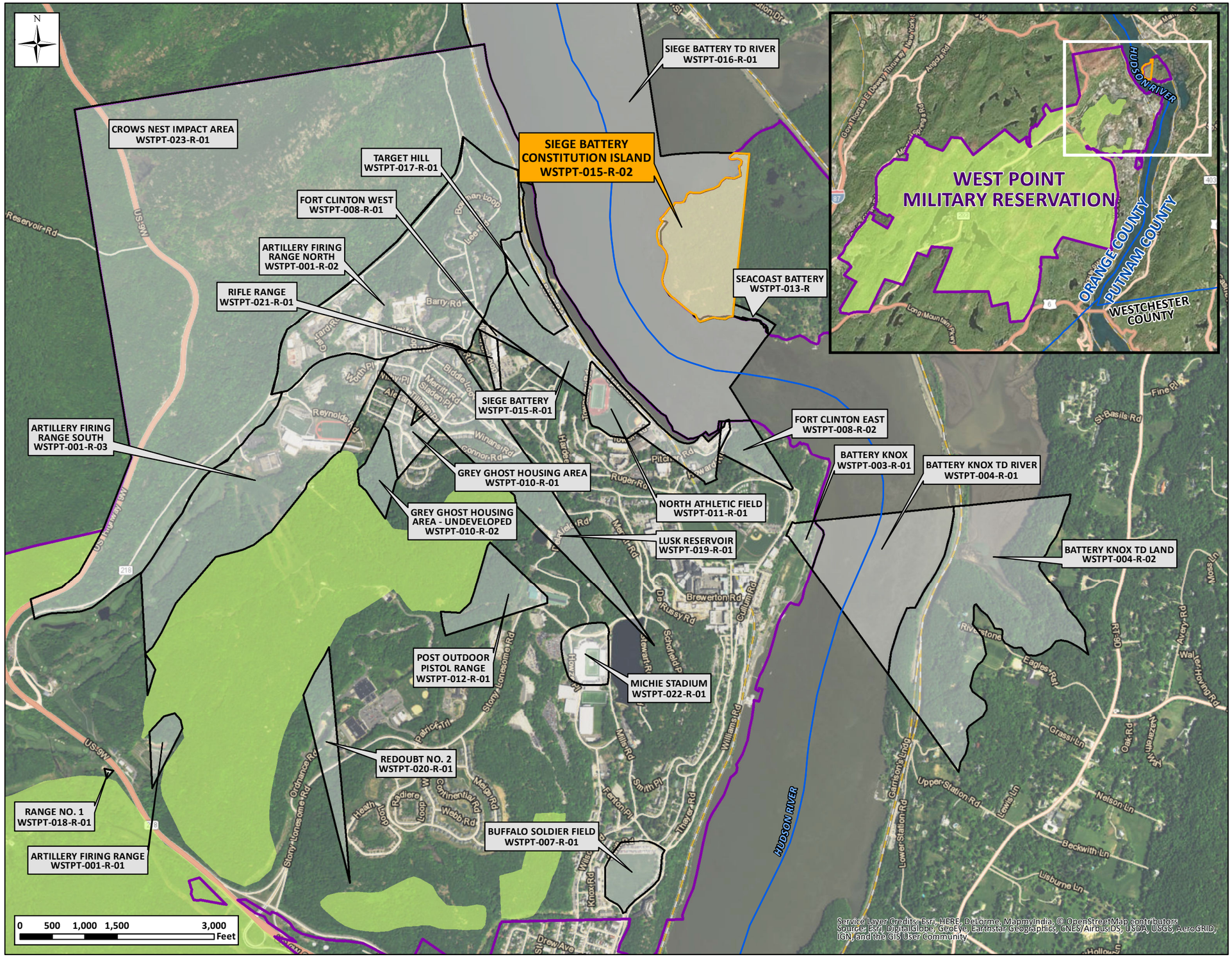
Date: March 2017

FIGURE 1-1

Regional Location Map

Feasibility Study
Siege Battery - Constitution Island MRS
U.S. Army Garrison West Point
West Point, NY



Map Key:

- County Boundary
- West Point Boundary
- Siege Battery - Constitution Island MRS Boundary[1]
- MRS Boundary
- Operational Range Area

Notes:

[1] MRS boundary obtained from the GIS geodatabase received January 7TH, 2016 from U.S. Army Garrison West Point via the USACE.

Abbreviation Key:

MRS = Munition Response Site

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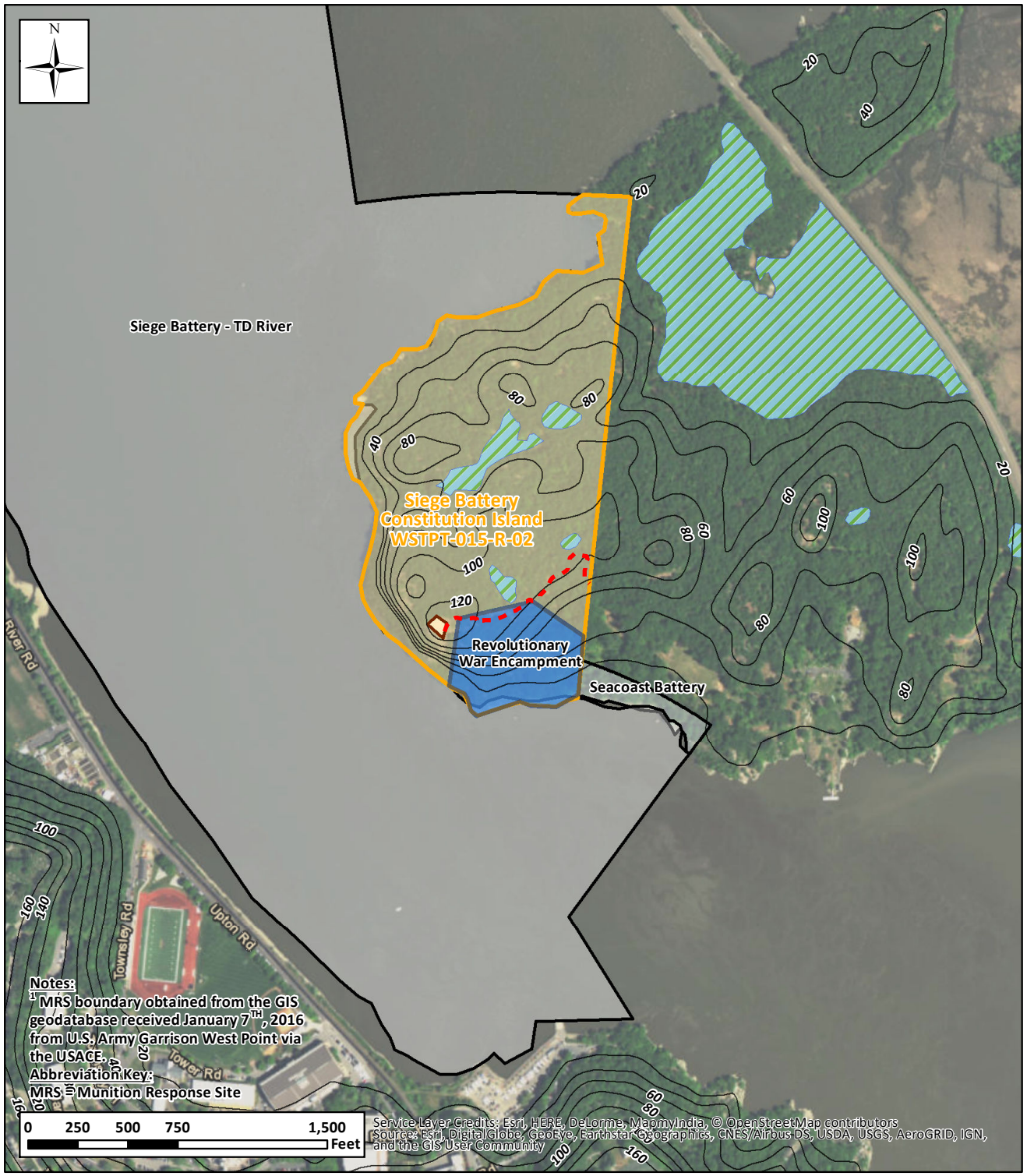
FIGURE 1-2

Siege Battery - Constitution Island MRS Location

Feasibility Study
Siege Battery - Constitution Island MRS
U.S. Army Garrison West Point
West Point, NY

C:\Users\bbouton\OneDrive - Plexus Scientific Corp\Documents\GIS_PRJ_BU\West Point MMRP\Maps\Siege Battery Constitution Island FS\Figure 1-2 - Siege Battery Constitution Island MRS.mxd

03/13/2017 12:57



Map Key:

- Siege Battery - Constitution Island MRS Boundary[1]
- Other MRS Boundary
- Cultural Resources
- Wetlands
- Redoubt No. 7
- Trail
- 20 foot Topographic Contour

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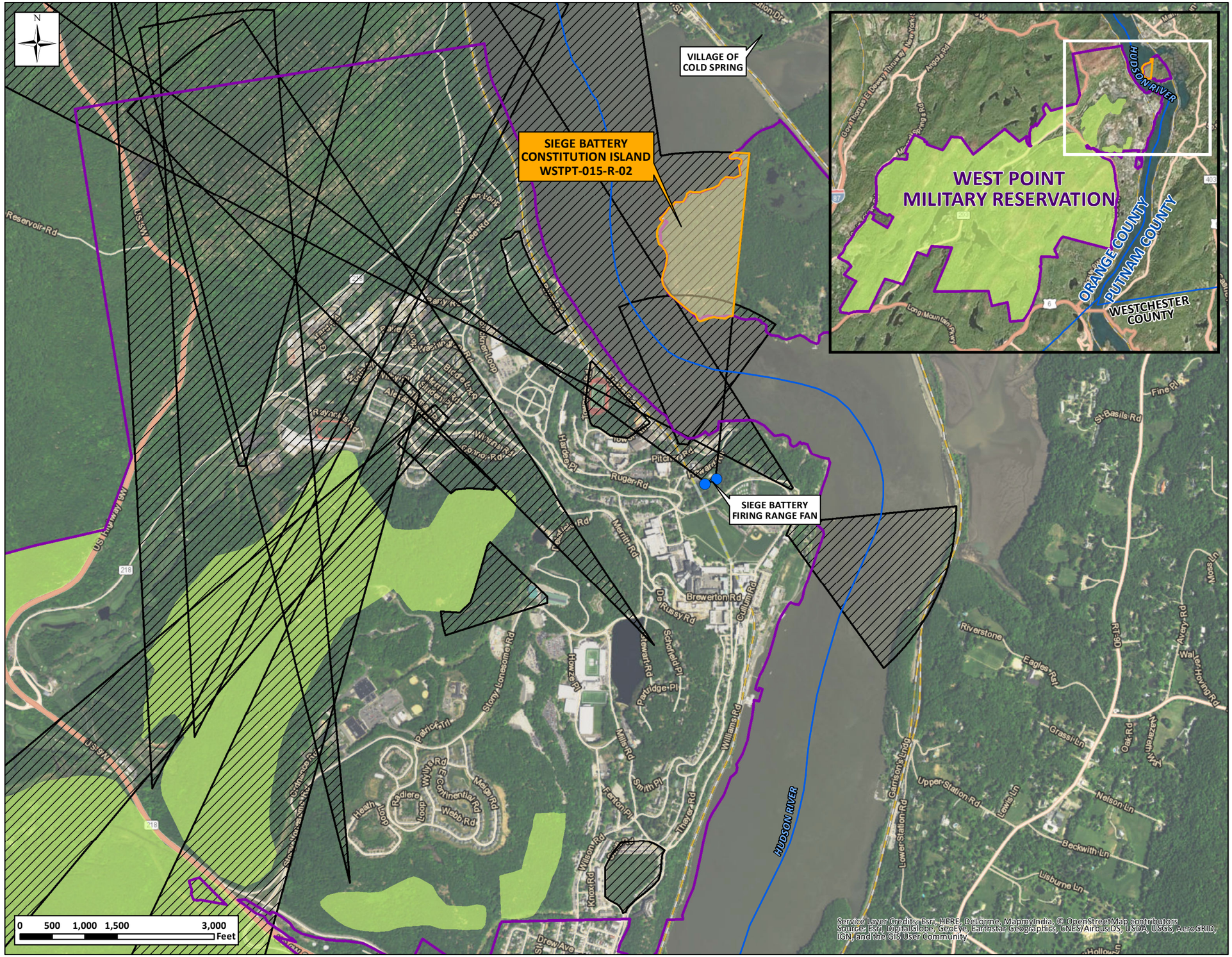
FIGURE 1-3

Siege Battery - Constitution Island MRS Site Layout

Feasibility Study
Siege Battery - Constitution Island MRS
U.S. Army Garrison West Point
West Point, NY

C:\Users\bbouton\OneDrive - Plexus Scientific Corp\Documents\GIS_PRJ_BU\West Point MMRP\Maps\Siege Battery Constitution Island FS\Figure 1-3 - Siege Battery Constitution Island Site Layout.mxd 04/03/2017 12:15



Map Key:

- County Boundary
- West Point Boundary
- Siege Battery - Constitution Island MRS Boundary[1]
- MRS Boundary
- Firing Range Fan
- Historical Firing Point
- Operational Range Area

Notes:

[1] MRS boundary obtained from the GIS geodatabase received January 7TH, 2016 from U.S. Army Garrison West Point via the USACE.

Abbreviation Key:

MRS = Munition Response Site

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FIGURE 1-4

Siege Battery - Constitution Island MRS and Firing Range Fans

Feasibility Study
Siege Battery - Constitution Island MRS
U.S. Army Garrison West Point
West Point, NY

Map Key:

- Siege Battery - Constitution Island MRS Boundary[1]
- Frag
- Mag and Dig Transects

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Date: March 2017

FIGURE 1-5

Siege Battery - Constitution Island MRS Dig Results

Feasibility Study
Siege Battery - Constitution Island MRS
U.S. Army Garrison West Point
West Point, NY

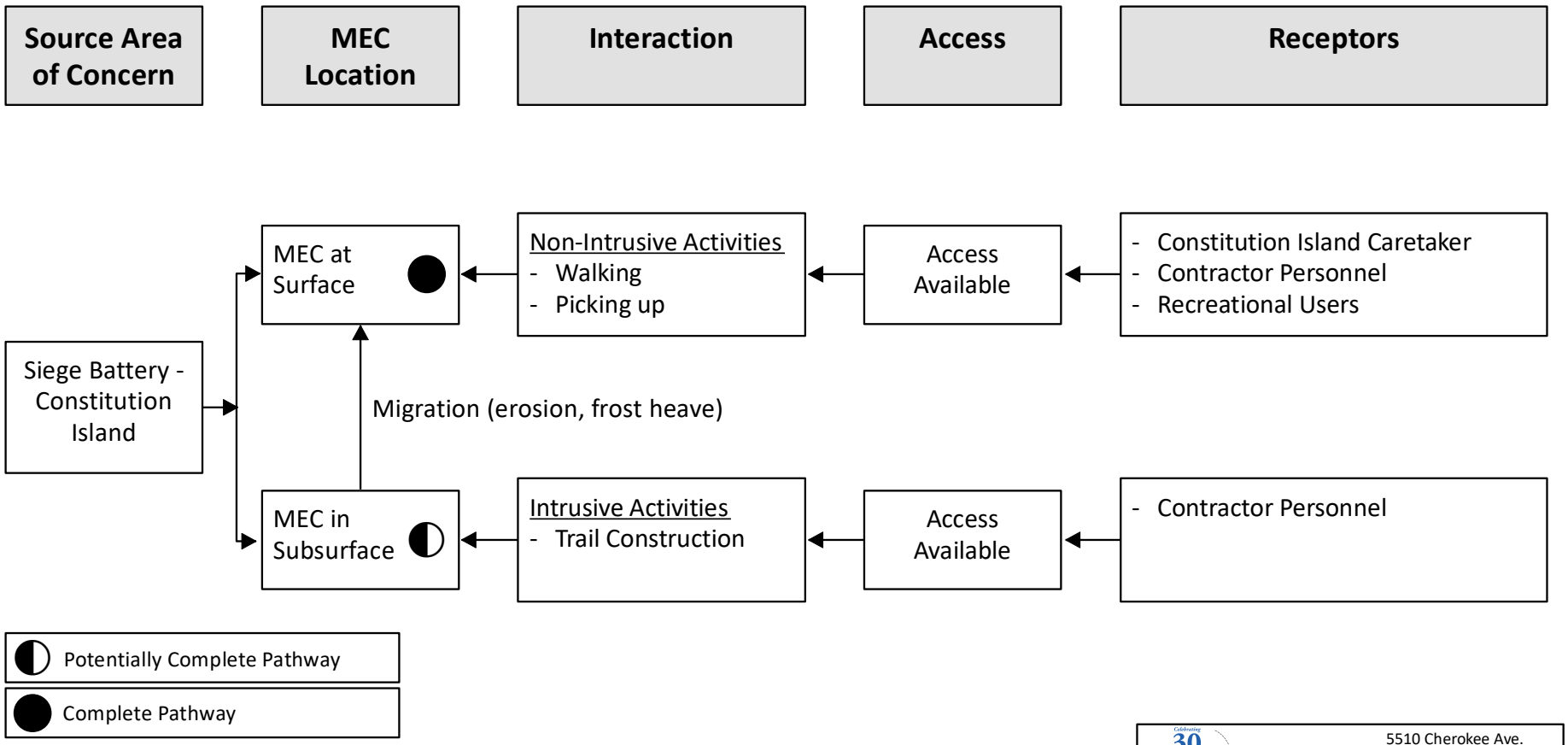

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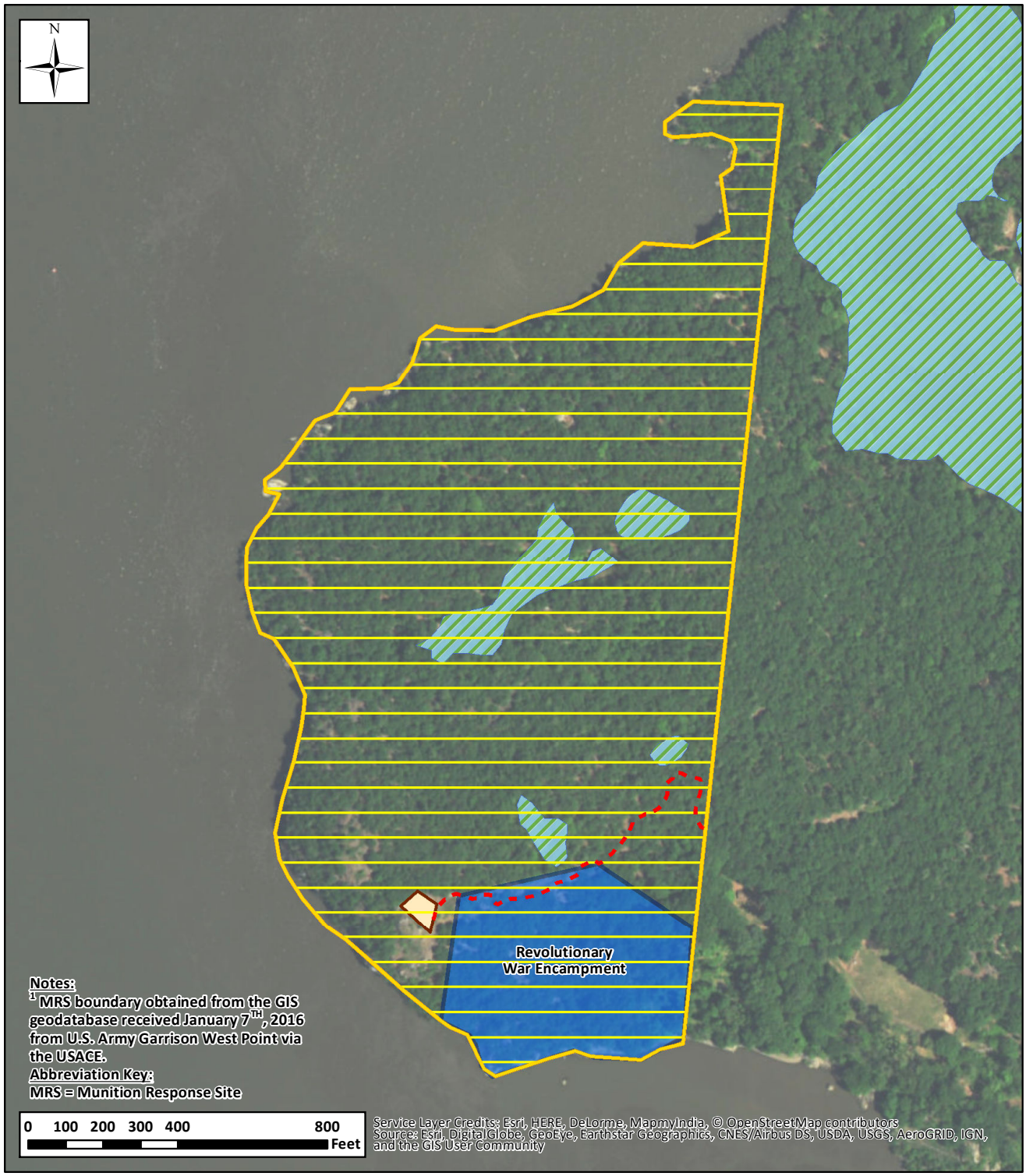
FIGURE 1-6

Revised Conceptual Site Model

Feasibility Study
Siege Battery - Constitution Island MRS
U.S. Army Garrison West Point
West Point, NY



Map Key:

- Siege Battery - Constitution Island MRS Boundary[1]
- Land Use Controls
- Cultural Resources
- Wetlands
- Redoubt No. 7
- Trail

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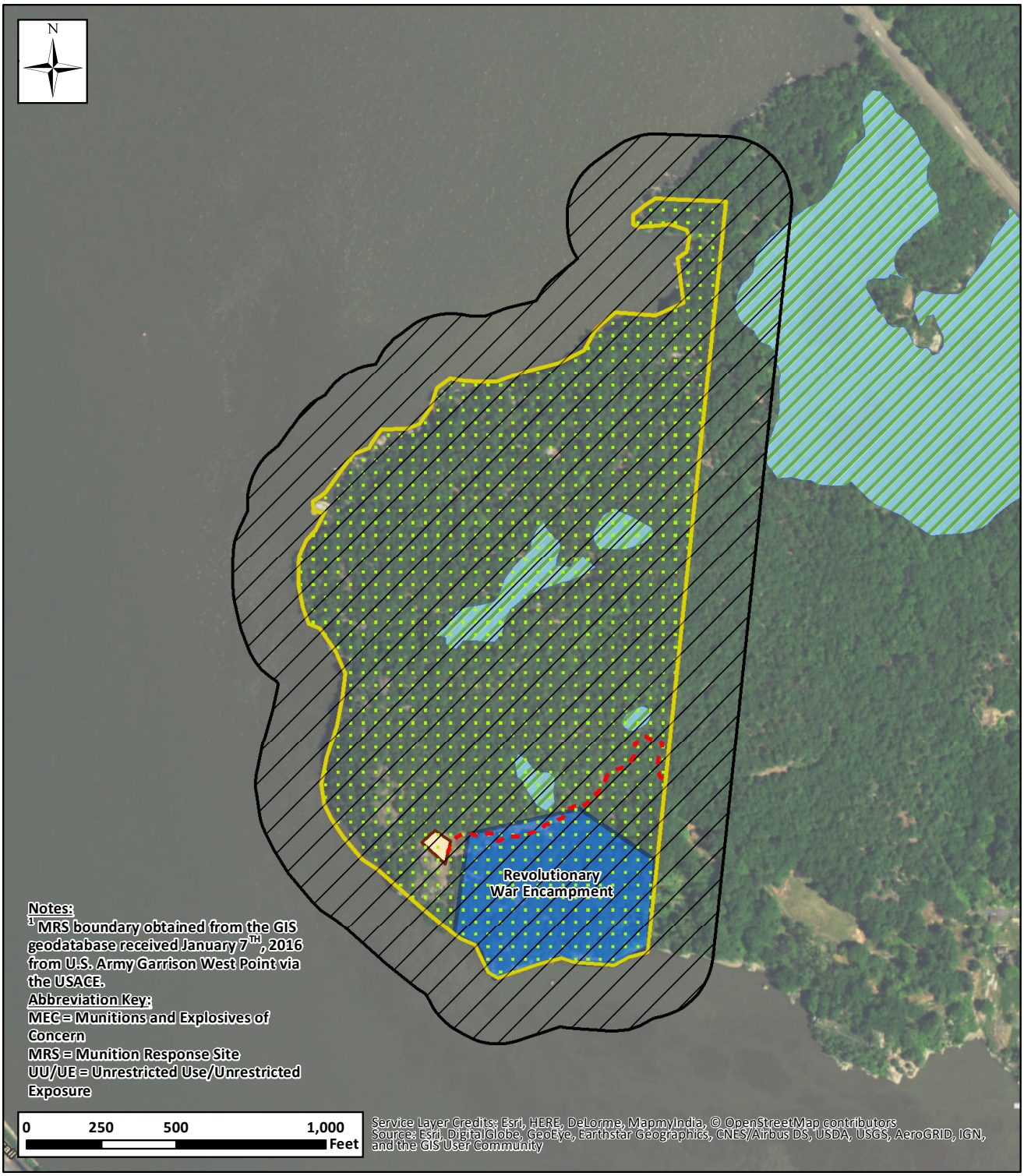
Date: March 2017

FIGURE 4-1

Alternative 2:
Risk Management

Feasibility Study
Siege Battery - Constitution Island MRS
U.S. Army Garrison West Point
West Point, NY



Map Key:

- Siege Battery - Constitution Island MRS Boundary[1]
- Surface/Subsurface Removal
- Exclusion Zone
- Cultural Resources
- Wetlands
- Redoubt No. 7
- Trail

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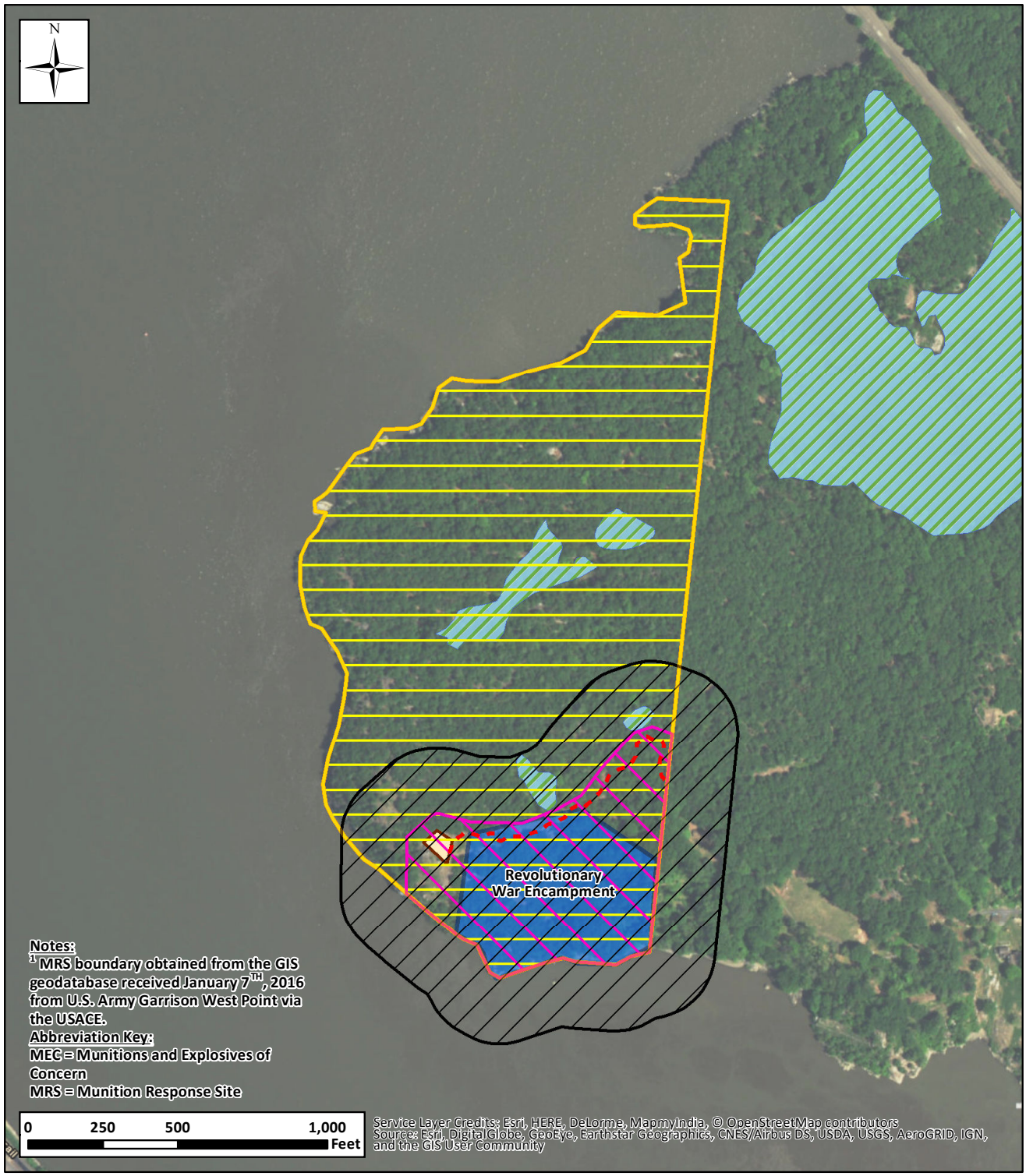
FIGURE 4-2

Alternative 3: MEC Removal to Qualify for UU/UE

Feasibility Study
Siege Battery - Constitution Island MRS
U.S. Army Garrison West Point
West Point, NY

C:\Users\bbouton\OneDrive - Plexus Scientific Corp\Documents\GIS_PRJ_BU\West Point MMRP\Maps\Siege Battery Constitution Island FS\Figure 4-2 - SBCI + Alt 3 MEC Removal.mxd 03/21/2017 12:23



Map Key:

- Siege Battery - Constitution Island MRS Boundary[1]
- Surface Removal
- Exclusion Zone
- Land Use Controls
- Cultural Resources
- Wetlands
- Redoubt No. 7
- Trail

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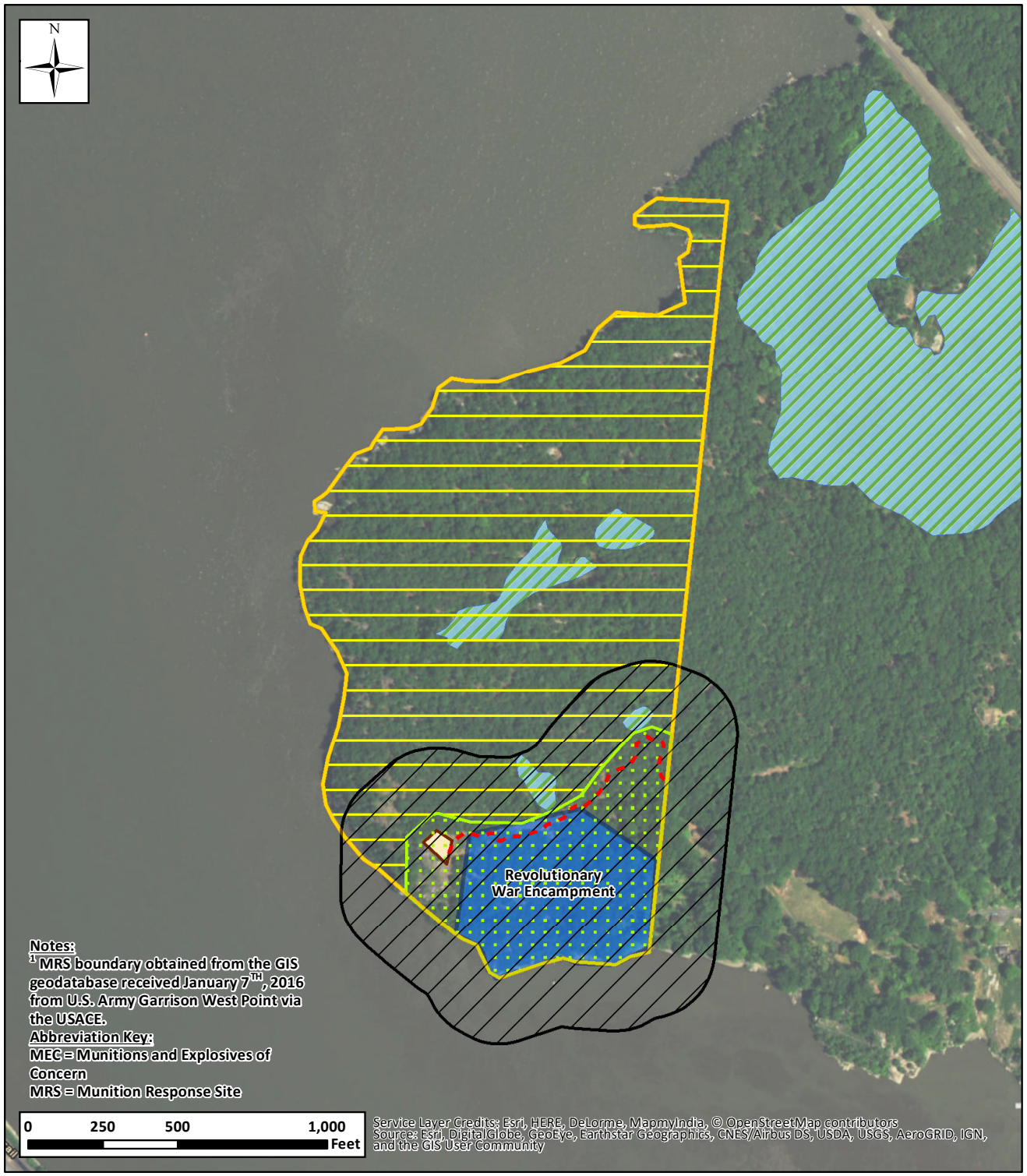
FIGURE 4-3

Alternative 4: Partial Surface MEC Removal with Risk Management

Feasibility Study
Siege Battery - Constitution Island MRS
U.S. Army Garrison West Point
West Point, NY

C:\Users\bbouton\OneDrive - Plexus Scientific Corp\Documents\GIS_PRJ_BU\West Point MMRP\Maps\Siege Battery Constitution Island FS\Figure 4-3 - SBCI + Alt 4 Partial MEC Removal with Risk Management.mxd 03/21/2017 12:29



Map Key:

- Siege Battery - Constitution Island MRS Boundary[1]
- Surface/Subsurface Removal
- Exclusion Zone
- Land Use Controls
- Cultural Resources
- Wetlands
- Redoubt No. 7
- Trail

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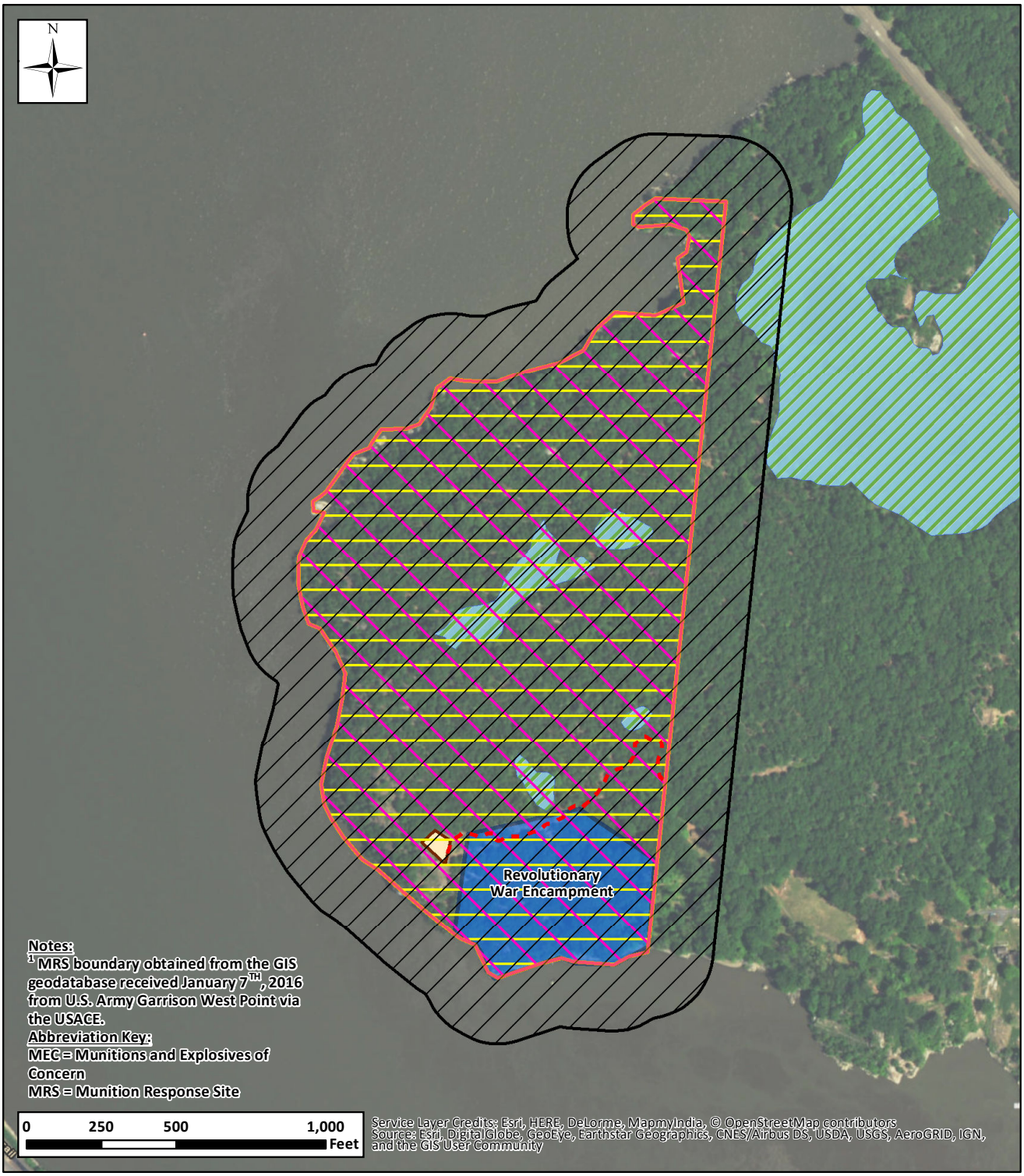
FIGURE 4-4

Alternative 5: Partial Surface/Subsurface MEC Removal with Risk Management

Feasibility Study
Siege Battery - Constitution Island MRS
U.S. Army Garrison West Point
West Point, NY

C:\Users\bbouton\OneDrive - Plexus Scientific Corp\Documents\GIS_PRJ_BU\West Point MMRP\Maps\Siege Battery Constitution Island FS\Figure 4-4 - SBCI + Alt 5 Partial Surface Subsurface MEC Removal with Risk Management.mxd 03/21/2017 12:39



Map Key:

- Siege Battery - Constitution Island MRS Boundary[1]
- Surface Removal
- Exclusion Zone
- Land Use Controls
- Cultural Resources
- Wetlands
- Redoubt No. 7
- Trail

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FIGURE 4-5

Alternative 6: Surface MEC Removal with Risk Management

Feasibility Study
Siege Battery - Constitution Island MRS
U.S. Army Garrison West Point
West Point, NY

C:\Users\bbouton\OneDrive - Plexus Scientific Corp\Documents\GIS_PRJ_BU\West Point MMRP\Maps\Siege Battery Constitution Island FS\Figure 4-5 - SBCI + Alt 6 Complete Surface MEC Removal with Risk Management.mxd 03/21/2017 12:46

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APPENDIX A

ALTERNATIVES MUNITIONS AND EXPLOSIVES OF CONCERN HAZARD ASSESSMENTS

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MEC HA Workbook v1.02

December-07

Overview

This workbook is a tool for project teams to assess explosive hazards to human receptors at munitions response sites (MRSs) following the Munitions and Explosives of Concern Hazard Assessment (MEC HA) methodology. The MEC HA allows a project team to evaluate potential explosive hazard associated with a site, given current site conditions, under various cleanup, land use activities, and land use control alternatives. A complete description of the methodology can be found in the MEC HA Guidance (Public Review Draft, November 2006). Please reference this guidance when completing the worksheets.

Instructions

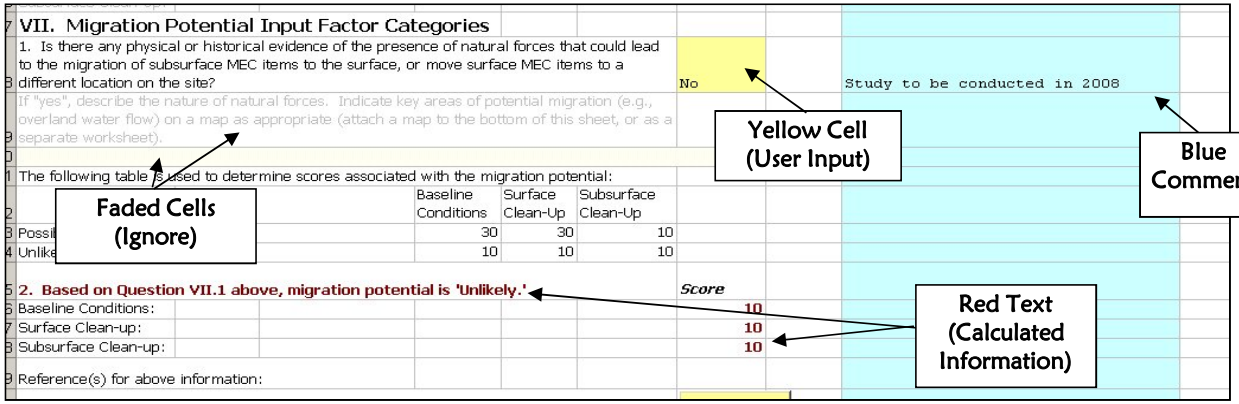
1. Open this file. Enable macros if prompted to do so. This spreadsheet will not work if your security setting is set to 'high' or 'very high'. To change your security level, go to the menu bar and select Tools/Macro/Security. Then close and reopen this spreadsheet.

2. This MS Excel workbook contains 9 worksheets, designed to be used in order. After the '***Instructions***' sheet, the first 5 sheets ask for information about the following topics:

Summary Info - General information regarding the site.
Munitions/Explosive Info - MECs and bulk explosives present at the site.
Current and Future Activities - Current land use activites as well as planned future activities, if any.
Remedial-Removal Action - General information regarding remediation/removal alternatives being considered for the site.
Post-Response Land Use - Land use activities associated with the alternatives listed in the 'Remedial-Removal Action' sheet.

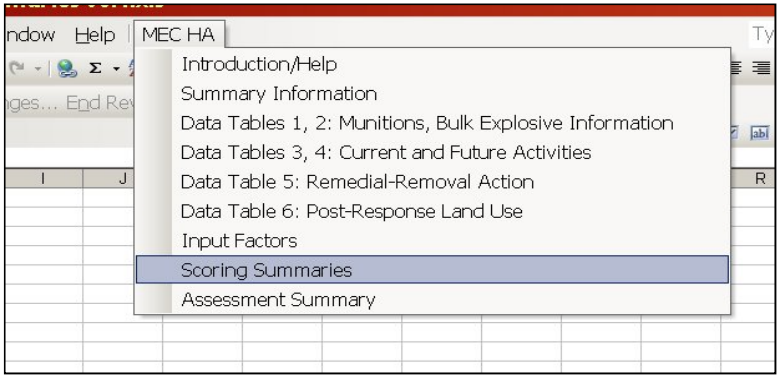
The remaining 3 sheets calculate and summarize the scores. The ***Input Factors*** sheet performs the Input Factor Score calculations, which are summarized in the ***Scoring Summaries*** sheet. The ***Hazard Level*** sheet presents the Hazard Level Category for current use activities, future use activities, and each response alternative based on the respective scores.

3. Starting with the ***Summary Info*** sheet, fill in any yellow cells. Some cells have drop-down lists from which you can select an answer. Select the cell. A down arrow to the right indicates that a drop-down list is available. Yellow buttons can be used to enter reference information. Blue cells can be used for any general comments you wish to make. Any faded cells can be ignored--these are questions that the spreadsheet has determined are not relevant for your situation.

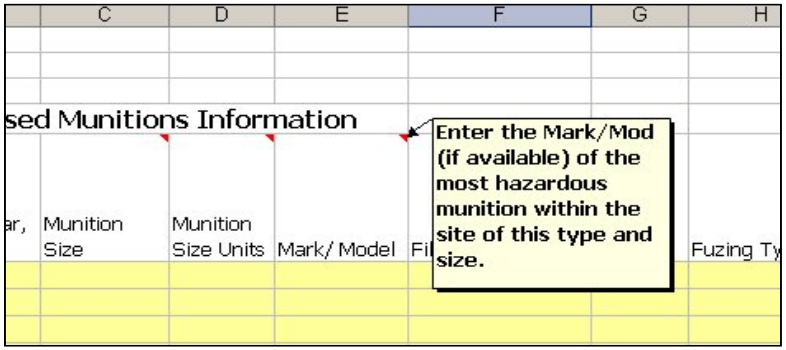


The computer will calculate information based on your inputs. Calculated information

4. The MEC HA menu bar can be used to navigate to different worksheets.



5. Small red triangles in the upper-right corners indicate that help text is available by putting the mouse cursor on that cell.



MEC HA Summary Information

Comments

Site ID: Siege Battery Constitution Island
Date: 3/13/2017

Please identify the single specific area to be assessed in this hazard assessment. From this point forward, all references to "site" or "MRS" refer to the specific area that you have defined.

A. Enter a unique identifier for the site:

(WSTPT-013-R-02) Siege Battery Constitution Island

Provide a list of information sources used for this hazard assessment. As you are completing the worksheets, use the "Select Ref(s)" buttons at the ends of each subsection to select the applicable information sources from the list below.

Ref. No.	Title (include version, publication date)
1	Site Inspection, Final, 2007
2	Field Investigations, 2011
3	RI Explosives Site Plan Amendment 1, 2011
4	RI, Final, 2015
5	
6	
7	
8	
9	
10	
11	
12	

B. Briefly describe the site:

1. Area (include units): Approximately 52 acres
2. Past munitions-related use:

Safety Buffer Areas

3. Current land-use activities (list all that occur):

Recreational

4. Are changes to the future land-use planned? No
5. What is the basis for the site boundaries?

A portion of the range fan for the Siege Battery that extends over Constitution Island. The Hudson River bounds to the north, west, and south.

6. How certain are the site boundaries?

Confident in boundaries

Reference(s) for Part B:

Select Ref(s)

C. Historical Clearances

1. Have there been any historical clearances at the site? No, none
2. If a clearance occurred:
   a. What year was the clearance performed?
   b. Provide a description of the clearance activity (e.g., extent, depth, amount of munitions-related items removed, types and sizes of removed items, and whether metal detectors were used):

Reference(s) for Part C:

Select Ref(s)

D. Attach maps of the site below (select 'Insert/Picture' on the menu bar.)

Site ID: **Siege Battery Constitution Island**
Date: **3/13/2017**

Cased Munitions Information

Item No.	Munition Type (e.g., mortar, projectile, etc.)	Munition Size	Munition Size Units	Mark/ Model	Energetic Material Type	Is Munition Fuzed?	Fuzing Type	Fuze Condition	Minimum Depth for Munition (ft)	Location of Munitions	Comments (include rationale for munitions that are "subsurface only")
1	Mortars	3	inches	Stokes	High Explosive	No	UNK	UNK	0	Surface and Subsurface	A 3-inch Stokes mortar was identified during the SI visual surveys. No MEC was identified during the RI.
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16											
17											
18											
19											
20											

Reference(s) for table above:

Select Ref(s)

Bulk Explosive Information

Item No.	Explosive Type	Comments
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Reference(s) for table above:

Select Ref(s)

Site ID: **Siege Battery Constitution Island**
Date: **3/13/2017**

Activities Currently Occurring at the Site

Activity No.	Activity	Number of people per year who participate in the activity	Number of hours per year a single person spends on the activity	Potential Contact Time (receptor hours/year)	Maximum intrusive depth (ft)	Comments
1	Recreational	365	1	**365**	0	
2	Contractor personnel	4	40	**160**	2	Trail maintenance
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
	Total Potential Contact Time (receptor hrs/yr):			**525**		
	Maximum intrusive depth at site (ft):				**2**	

Reference(s) for table above:

Select Ref(s)

Activities Planned for the Future at the Site (If any are planned: see 'Summary Info' Worksheet, Question 4)

Activity No.	Activity	Number of people per year who participate in the activity	Number of hours per year a single person spends on the activity	Potential Contact Time (receptor hours/year)	Maximum intrusive depth (ft)	Comments
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Total Potential Contact Time (receptor hrs/yr):

Maximum intrusive depth at site (ft):

Reference(s) for table above:

Select Ref(s)

Site ID: **Siege Battery Constitution Island**
Date: **3/13/2017**

Planned Remedial or Removal Actions

Response Action No.	Response Action Description	Expected Resulting Minimum MEC Depth (ft)	Expected Resulting Site Accessibility	Will land use activities change if this response action is implemented?	What is the expected scope of cleanup?	Comments
1	No Action	0	Moderate Accessibility	No	No MEC cleanup	
2	Risk Management	0	Moderate Accessibility	No	No MEC cleanup	52ac LUCs.
3	Not retained					52ac removal.
4	Not retained					10ac surface removal, 52ac LUCs.
5	Partial Surface/Subsurface MEC Removal with Risk Management	0	Moderate Accessibility	No	cleanup of MECs located both on the surface and subsurface	10ac surface/subsurface removal with 42ac LUCs.
6	Not retained					52ac surface removal, 52ac LUCs.

According to the 'Summary Info' worksheet, no future land uses are planned. For those alternatives where you answered 'No' in Column E, the land use activities will be assessed against current land uses.

Reference(s) for table above:

Select Ref(s)

Site ID: **Siege Battery Constitution Island**
Date: **3/13/2017**

This worksheet needs to be completed for each remedial/removal action alternative listed in the 'Remedial-Removal Action' worksheet that will cause a change in land use.

Land Use Activities Planned After Response Alternative #1: No Action

Activity No.	Activity	Number of people per year who participate in the activity	Number of hours a single person spends on the activity	Potential Contact Time (receptor hours/year)	Maximum intrusive depth (ft)	Comments
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Total Potential Contact Time (receptor hrs/yr):
Maximum intrusive depth at site (ft):

Reference(s) for table above:

Select Ref(s)

Land Use Activities Planned After Response Alternative #2: Risk Management

Activity No.	Activity	Number of people per year who participate in the activity	Number of hours a single person spends on the activity	Potential Contact Time (receptor hours/year)	Maximum intrusive depth (ft)	Comments
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Total Potential Contact Time (receptor hrs/yr):

Maximum intrusive depth at site (ft):

Reference(s) for table above:

Select Ref(s)

Land Use Activities Planned After Response Alternative #3: Not retained

Activity No.	Activity	Number of people per year who participate in the activity	Number of hours a single person spends on the activity	Potential Contact Time (receptor hours/year)	Maximum intrusive depth (ft)	Comments
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Total Potential Contact Time (receptor hrs/yr):

Maximum intrusive depth at site (ft):

Reference(s) for table above:

Select Ref(s)

Land Use Activities Planned After Response Alternative #4: Not retained

Activity No.	Activity	Number of people per year who participate in the activity	Number of hours a single person spends on the activity	Potential Contact Time (receptor hours/year)	Maximum intrusive depth (ft)	Comments
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Total Potential Contact Time (receptor hrs/yr):

Maximum intrusive depth at site (ft):

Reference(s) for table above:

Select Ref(s)

Land Use Activities Planned After Response Alternative #5: Partial Surface/Subsurface MEC Removal with Risk Management

Activity No.	Activity	Number of people per year who participate in the activity	Number of hours a single person spends on the activity	Potential Contact Time (receptor hours/year)	Maximum intrusive depth (ft)	Comments
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Total Potential Contact Time (receptor hrs/yr):

Maximum intrusive depth at site (ft):

Reference(s) for table above:

Select Ref(s)

Land Use Activities Planned After Response Alternative #6: Not retained

Activity No.	Activity	Number of people per year who participate in the activity	Number of hours a single person spends on the activity	Potential Contact Time (receptor hours/year)	Maximum intrusive depth (ft)	Comments
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Total Potential Contact Time (receptor hrs/yr):

Maximum intrusive depth at site (ft):

Reference(s) for table above:

Select Ref(s)

Site ID: **Siege Battery Constitution Island**

Date: **3/13/2017**

Energetic Material Type Input Factor Categories

The following table is used to determine scores associated with the energetic materials. Materials are listed in order from most hazardous to least hazardous.

	Baseline Conditions	Surface Cleanup	Subsurface Cleanup
High Explosive and Low Explosive Filler in Fragmenting Rounds	100	100	100
White Phosphorus	70	70	70
Pyrotechnic	60	60	60
Propellant	50	50	50
Spotting Charge	40	40	40
Incendiary	30	30	30

The most hazardous type of energetic material listed in the 'Munitions, Bulk Explosive Info' Worksheet falls under the category 'High Explosive and Low Explosive Filler in Fragmenting Rounds'. ***Score***

Baseline Conditions:	**100**
Surface Cleanup:	**100**
Subsurface Cleanup:	**100**

Comments

Location of Additional Human Receptors Input Factor Categories

1. What is the Explosive Safety Quantity Distance (ESQD) from the Explosive Siting Plan or the Explosive Safety Submission for the MRS? 219 feet

2. Are there currently any features or facilities where people may congregate within the MRS, or within the ESQD arc? No

3. Please describe the facility or feature.

MEC Item(s) used to calculate the ESQD for current use activities

Select MEC(s)

The following table is used to determine scores associated with the location of additional human receptors (current use activities):

	Baseline Conditions	Surface Cleanup	Subsurface Cleanup
Inside the MRS or inside the ESQD arc	30	30	30
Outside of the ESQD arc	0	0	0

4. Current use activities are 'Outside of the ESQD arc', based on Question 2.'

	Score
Baseline Conditions:	**0**
Surface Cleanup:	**0**
Subsurface Cleanup:	**0**

Unintentional detonations, hazardous fragment distance.

5. Are there future plans to locate or construct features or facilities where people may congregate within the MRS, or within the ESQD arc?

6. Please describe the facility or feature.

MEC Item(s) used to calculate the ESQD for future use activities

Select MEC(s)

The following table is used to determine scores associated with the location of additional human receptors (future use activities):

	Baseline Conditions	Surface Cleanup	Subsurface Cleanup
Inside the MRS or inside the ESQD arc	30	30	30
Outside of the ESQD arc	0	0	0

7. Please answer Question 5 above to determine the scores. ***Score***

Baseline Conditions:
Surface Cleanup:
Subsurface Cleanup:

Site Accessibility Input Factor Categories

The following table is used to determine scores associated with site accessibility:

	Description	Baseline Conditions	Surface Cleanup	Subsurface Cleanup
Full Accessibility	No barriers to entry, including signage but no fencing	80	80	80
Moderate Accessibility	Some barriers to entry, such as barbed wire fencing or rough terrain	55	55	55
Limited Accessibility	Significant barriers to entry, such as unguarded chain link fence or requirements for special transportation to reach the site	15	15	15
Very Limited Accessibility	A site with guarded chain link fence or terrain that requires special equipment and skills (e.g., rock climbing) to access	5	5	5

Current Use Activities ***Score***

Select the category that best describes the site accessibility under the current use scenario:

Moderate Accessibility

Baseline Conditions: **55**
Surface Cleanup: **55**
Subsurface Cleanup: **55**

Potential Contact Hours Input Factor Categories

Select Ref(s)

The following table is used to determine scores associated with the total potential contact time:

	Description	Baseline Conditions	Surface Cleanup	Subsurface Cleanup
Many Hours	≥1,000,000 receptor-hrs/yr	120	90	30
Some Hours	100,000 to 999,999 receptor hrs/yr	70	50	20
Few Hours	10,000 to 99,999 receptor-hrs/yr	40	20	10
Very Few Hours	<10,000 receptor-hrs/yr	15	10	5

Current Use Activities:

Input factors are only determined for baseline conditions for current use activities. Based on the 'Current and Future Activities' Worksheet, the Total Potential Contact Time is: **525** receptor hrs/yr

Based on the table above, this corresponds to a input factor score for baseline conditions of: **15** Score

Amount of MEC Input Factor Categories

The following table is used to determine scores associated with the Amount of MEC:

	Description	Baseline Conditions	Surface Cleanup	Subsurface Cleanup
Target Area	Areas at which munitions fire was directed	180	120	30
OB/OD Area	Sites where munitions were disposed of by open burn or open detonation methods. This category refers to the core activity area of an OB/OD area. See the "Safety Buffer Areas" category for safety fans and kick-outs.	180	110	30
Function Test Range	Areas where the serviceability of stored munitions or weapons systems are tested. Testing may include components, partial functioning or complete functioning of stockpile or developmental items.	165	90	25
Burial Pit	The location of a burial of large quantities of MEC items.	140	140	10
Maneuver Areas	Areas used for conducting military exercises in a simulated conflict area or war zone	115	15	5
Firing Points	The location from which a projectile, grenade, ground signal, rocket, guided missile, or other device is to be ignited, propelled, or released.	75	10	5
Safety Buffer Areas	Areas outside of target areas, test ranges, or OB/OD areas that were designed to act as a safety zone to contain munitions that do not hit targets or to contain kick-outs from OB/OD areas.	30	10	5
Storage	Any facility used for the storage of military munitions, such as earth-covered magazines, above-ground magazines, and open-air storage areas.	25	10	5
Explosive-Related Industrial Facility	Former munitions manufacturing or demilitarization sites and TNT production plants	20	10	5

Select the category that best describes the ***most hazardous*** amount of MEC: ***Score***

Safety Buffer Areas

Baseline Conditions: **30**
Surface Cleanup: **10**
Subsurface Cleanup: **5**

Minimum MEC Depth Relative to the Maximum Intrusive Depth Input Factor Categories

Current Use Activities

The shallowest minimum MEC depth, based on the 'Cased Munitions Information' Worksheet: **0** ft
The deepest intrusive depth: **0** ft
The table below is used to determine scores associated with the minimum MEC depth relative to the maximum intrusive depth:

	Baseline Conditions	Surface Cleanup	Subsurface Cleanup
Baseline Condition: MEC located surface and subsurface. After Cleanup: Intrusive depth overlaps with subsurface MEC.	240	150	95
Baseline Condition: MEC located surface and subsurface, After Cleanup: Intrusive depth does not overlap with subsurface MEC.	240	50	25
Baseline Condition: MEC located only subsurface. Baseline Condition or After Cleanup: Intrusive depth overlaps with minimum MEC depth.	150	N/A	95
Baseline Condition: MEC located only subsurface. Baseline Condition or After Cleanup: Intrusive depth does not overlap with minimum MEC depth.	50	N/A	25

Because the shallowest minimum MEC depth is less than or equal to the deepest intrusive depth, the intrusive depth will overlap after cleanup. MECs are located at both the surface and subsurface, based on the 'Munitions, Bulk Explosive Info' Worksheet. Therefore, the category for this input factor is 'Baseline Condition: MEC located surface and subsurface. After Cleanup: Intrusive depth overlaps with subsurface MEC.' For 'Current Use Activities', only Baseline Conditions are considered.

240 ***Score***

Future Use Activities

Deepest intrusive depth: **0** ft

Because the shallowest minimum MEC depth is less than or equal to the deepest intrusive depth, the intrusive depth overlaps. MECs are located at both the surface and subsurface, based on the 'Munitions, Bulk Explosive Info' Worksheet. Therefore, the category for this input factor is 'Baseline Condition: MEC located surface and subsurface. After Cleanup: Intrusive depth overlaps with subsurface MEC.'. For 'Future Use Activities', only Baseline Conditions are considered.

240 ***Score***

Migration Potential Input Factor Categories

Is there any physical or historical evidence that indicates it is possible for natural physical forces in the area (e.g., frost heave, erosion) to expose subsurface MEC items, or move surface or subsurface MEC items? Yes

If "yes", describe the nature of natural forces. Indicate key areas of potential migration (e.g., overland water flow) on a map as appropriate (attach a map to the bottom of this sheet, or as a separate worksheet).

erosion of the shoreline

The following table is used to determine scores associated with the migration potential:

	Baseline Conditions	Surface Cleanup	Subsurface Cleanup
Possible	30	30	10
Unlikely	10	10	10

Based on the question above, migration potential is 'Possible.'

	Score
Baseline Conditions:	**30**
Surface Cleanup:	**30**
Subsurface Cleanup:	**10**

Reference(s) for above information:

Select Ref(s)

MEC Classification Input Factor Categories

Cased munitions information has been inputed into the 'Munitions, Bulk Explosive Info' Worksheet; therefore, bulk explosives do not comprise all MECs for this MRS.

The 'Amount of MEC' category is 'Safety Buffer Areas'. It cannot be automatically assumed that the MEC items from this category are DMM. Therefore, the conservative assumption is that the MEC items in this MRS are UXO.

Has a technical assessment shown that MEC in the OB/OD Area is DMM?

Are any of the munitions listed in the 'Munitions, Bulk Explosive Info' Worksheet: Yes

- Submunitions
- Rifle-propelled 40mm projectiles (often called 40mm grenades)
- Munitions with white phosphorus filler
- High explosive anti-tank (HEAT) rounds
- Hand grenades
- Fuzes
- Mortars

None of the items listed in the 'Munitions, Bulk Explosive Info' Worksheet were identified as 'fuzed'.

The following table is used to determine scores associated with MEC classification categories:

UXO Special Case	Baseline Conditions	Surface Cleanup	Subsurface Cleanup
UXO Special Case	180	180	180
UXO	110	110	110
Fuzed DMM Special Case	105	105	105
Fuzed DMM	55	55	55
Unfuzed DMM	45	45	45
Bulk Explosives	45	45	45

Based on your answers above, the MEC classification is 'UXO Special Case'.

	Score
Baseline Conditions:	**180**
Surface Cleanup:	**180**
Subsurface Cleanup:	**180**

MEC Size Input Factor Categories

The following table is used to determine scores associated with MEC Size:

	Description	Baseline Conditions	Surface Cleanup	Subsurface Cleanup
Small	Any munitions (from the 'Munitions, Bulk Explosive Info' Worksheet) weigh less than 90 lbs; small enough for a receptor to be able to move and initiate a detonation	40	40	40
Large	All munitions weigh more than 90 lbs; too large to move without equipment	0	0	0

Based on the definitions above and the types of munitions at the site (see 'Munitions, Bulk Explosive Info' Worksheet), the MEC Size Input Factor is: Small

	Score
Baseline Conditions:	**40**
Surface Cleanup:	**40**
Subsurface Cleanup:	**40**

Scoring Summary

Site ID:	Siege Battery Constitution Island	a. Scoring Summary for Current Use Activities	
Date:	3/13/2017	Response Action Cleanup:	No Response Action
Input Factor		**Input Factor Category**	**Score**
I. Energetic Material Type		High Explosive and Low Explosive Filler in Fragmenting Rounds	100
II. Location of Additional Human Receptors		Outside of the ESQD arc	0
III. Site Accessibility		Moderate Accessibility	55
IV. Potential Contact Hours		<10,000 receptor-hrs/yr	15
V. Amount of MEC		Safety Buffer Areas	30
VI. Minimum MEC Depth Relative to Maximum Intrusive Depth		Baseline Condition: MEC located surface and subsurface. After Cleanup: Intrusive depth overlaps with subsurface MEC.	240
VII. Migration Potential		Possible	30
VIII. MEC Classification		UXO Special Case	180
IX. MEC Size		Small	40
		Total Score	**690**
		Hazard Level Category	**3**

Site ID:	Siege Battery Constitution Island	b. Scoring Summary for Future Use Activities	
Date:	3/13/2017	Response Action Cleanup:	No Response Action
Input Factor		**Input Factor Category**	**Score**
I. Energetic Material Type		High Explosive and Low Explosive Filler in Fragmenting Rounds	100
II. Location of Additional Human Receptors			
III. Site Accessibility			
IV. Potential Contact Hours			
V. Amount of MEC		Safety Buffer Areas	30
VI. Minimum MEC Depth Relative to Maximum Intrusive Depth		Baseline Condition: MEC located surface and subsurface. After Cleanup: Intrusive depth overlaps with subsurface MEC.	240
VII. Migration Potential		Possible	30
VIII. MEC Classification		UXO Special Case	180
IX. MEC Size		Small	40
		Total Score	**620**
		Hazard Level Category	**3**

Site ID:	Siege Battery Constitution Island	c. Scoring Summary for Response Alternative 1: No Action	
Date:	3/13/2017	Response Action Cleanup:	No MEC cleanup
Input Factor		**Input Factor Category**	**Score**
I. Energetic Material Type		High Explosive and Low Explosive Filler in Fragmenting Rounds	100
II. Location of Additional Human Receptors		Outside of the ESQD arc	0
III. Site Accessibility		Moderate Accessibility	55
IV. Potential Contact Hours		<10,000 receptor-hrs/yr	15
V. Amount of MEC		Safety Buffer Areas	30
VI. Minimum MEC Depth Relative to Maximum Intrusive Depth		Baseline Condition: MEC located surface and subsurface. After Cleanup: Intrusive depth overlaps with subsurface MEC.	240
VII. Migration Potential		Possible	30
VIII. MEC Classification		UXO Special Case	180
IX. MEC Size		Small	40
		Total Score	**690**
		Hazard Level Category	**3**

Site ID:	Siege Battery Constitution Island	d. Scoring Summary for Response Alternative 2: Risk Management	
Date:	3/13/2017	Response Action Cleanup:	No MEC cleanup
Input Factor		**Input Factor Category**	**Score**
I. Energetic Material Type		High Explosive and Low Explosive Filler in Fragmenting Rounds	100
II. Location of Additional Human Receptors		Outside of the ESQD arc	0
III. Site Accessibility		Moderate Accessibility	55
IV. Potential Contact Hours		<10,000 receptor-hrs/yr	15
V. Amount of MEC		Safety Buffer Areas	30
VI. Minimum MEC Depth Relative to Maximum Intrusive Depth		Baseline Condition: MEC located surface and subsurface. After Cleanup: Intrusive depth overlaps with subsurface MEC.	240
VII. Migration Potential		Possible	30
VIII. MEC Classification		UXO Special Case	180
IX. MEC Size		Small	40
		Total Score	**690**
		Hazard Level Category	**3**

Site ID:	Siege Battery Constitution Island	e. Scoring Summary for Response Alternative 3: Not retained	
Date:	3/13/2017	Response Action Cleanup:	
Input Factor		**Input Factor Category**	**Score**
I. Energetic Material Type		High Explosive and Low Explosive Filler in Fragmenting Rounds	
II. Location of Additional Human Receptors		Outside of the ESQD arc	
III. Site Accessibility			
IV. Potential Contact Hours			
V. Amount of MEC		Safety Buffer Areas	
VI. Minimum MEC Depth Relative to Maximum Intrusive Depth			
VII. Migration Potential		Possible	
VIII. MEC Classification		UXO Special Case	
IX. MEC Size		Small	
		Total Score	
		Hazard Level Category	

Site ID:	Siege Battery Constitution Island	f. Scoring Summary for Response Alternative 4: Not retained	
Date:	3/13/2017	Response Action Cleanup:	
Input Factor		**Input Factor Category**	**Score**
I. Energetic Material Type		High Explosive and Low Explosive Filler in Fragmenting Rounds	
II. Location of Additional Human Receptors		Outside of the ESQD arc	
III. Site Accessibility			
IV. Potential Contact Hours			
V. Amount of MEC		Safety Buffer Areas	
VI. Minimum MEC Depth Relative to Maximum Intrusive Depth			
VII. Migration Potential		Possible	
VIII. MEC Classification		UXO Special Case	
IX. MEC Size		Small	
		Total Score	
		Hazard Level Category	

Site ID:	Siege Battery Constitution Island	g. Scoring Summary for Response Alternative 5: Partial Surface/Subsurface MEC Removal with Risk Manag	
Date:	3/13/2017	Response Action Cleanup:	cleanup of MECs located both on the surface and subsurface
Input Factor		**Input Factor Category**	**Score**
I. Energetic Material Type		High Explosive and Low Explosive Filler in Fragmenting Rounds	100
II. Location of Additional Human Receptors		Outside of the ESQD arc	0
III. Site Accessibility		Moderate Accessibility	55
IV. Potential Contact Hours		<10,000 receptor-hrs/yr	5
V. Amount of MEC		Safety Buffer Areas	5
VI. Minimum MEC Depth Relative to Maximum Intrusive Depth		Baseline Condition: MEC located surface and subsurface. After Cleanup: Intrusive depth overlaps with subsurface MEC.	95
VII. Migration Potential		Possible	10
VIII. MEC Classification		UXO Special Case	180
IX. MEC Size		Small	40
		Total Score	**490**
		Hazard Level Category	**4**

Site ID:	Siege Battery Constitution Island	h. Scoring Summary for Response Alternative 6: Not retained	
Date:	3/13/2017	Response Action Cleanup:	
Input Factor		**Input Factor Category**	**Score**
I. Energetic Material Type		High Explosive and Low Explosive Filler in Fragmenting Rounds	
II. Location of Additional Human Receptors		Outside of the ESQD arc	
III. Site Accessibility			
IV. Potential Contact Hours			
V. Amount of MEC		Safety Buffer Areas	
VI. Minimum MEC Depth Relative to Maximum Intrusive Depth			
VII. Migration Potential		Possible	
VIII. MEC Classification		UXO Special Case	
IX. MEC Size		Small	
		Total Score	
		Hazard Level Category	

MEC HA Hazard Level Determination		
Site ID: Siege Battery Constitution Island **Date:** 3/13/2017	**Hazard Level Category**	**Score**
a. Current Use Activities	**3**	**690**
b. Future Use Activities	**3**	**620**
c. Response Alternative 1: No Action	**3**	**690**
d. Response Alternative 2: Risk Management	**3**	**690**
e. Response Alternative 3: Not retained		
f. Response Alternative 4: Not retained		
g. Response Alternative 5: Partial Surface/Subsurface MEC Removal with Risk Management	**4**	**490**
h. Response Alternative 6: Not retained		

Characteristics of the MRS		
Is critical infrastructure located within the MRS or within the ESQD arc?	No	
Are cultural resources located within the MRS or within the ESQD arc?	Yes	Cultural resources are located outside of the MRS, but inside the ESQD arc.
Are significant ecological resources located within the MRS or within the ESQD arc?	Yes	Significant ecological resources are located outside of the MRS, but inside the ESQD arc.

APPENDIX B
INSTITUTIONAL ANALYSIS

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1.0 INTRODUCTION

This Institutional Analysis (IA) was prepared by Plexus Scientific Corporation (Plexus) in support of the United States Army Military Munitions Response Program at the United States Army Garrison (USAG) West Point located in West Point, New York. This IA was prepared in accordance with the *MMRP Remedial Investigation/Feasibility Study Guidance* (U.S. Army, 2009) and *Engineer Pamphlet (EP) 1110-1-24* (U.S. Army Corps of Engineers [USACE], 2000) to be utilized during the development of Feasibility Studies (FSs) for seven Munitions Response Sites (MRSs).

The development of FSs was recommended based on potential explosive hazards identified during remedial investigation activities conducted at each of the seven MRSs. The seven MRSs consist of a mixture of developed (housing, commercial, and service support) and undeveloped areas located within the Main Post and on Constitution Island. The name, identification, and acreage of the seven MRSs are identified in **Table 1-1**, and the location and layout of the seven MRSs are presented in **Figure 1-1**.

Table 1-1: Munitions Response Sites Summary

MRS	Identification	Acreage
Artillery Firing Range North	WSTPT-001-R-02	143.3
Artillery Firing Range South	WSTPT-001-R-03	123.4
Grey Ghost Housing Area – Undeveloped	WSTPT-010-R-02	11
Seacoast Battery	WSTPT-013-R-01	2
Siege Battery – Constitution Island	WSTPT-015-R-02	52
North Athletic Field	WSTPT-011-R-01	14
Target Hill	WSTPT-017-R-01	14

1.1 Overview

Typical strategies for addressing the presence of munitions and explosives of concern (MEC) are physical removals and risk management through land use controls (LUCs). Physical removal actions are conducted to reduce the amount of MEC at an MRS, while LUCs are implemented to manage the residual hazard of MEC remaining at an MRS.

LUCs limit access or use of a property to protect people from hazards, or provide warnings of a potential hazard. LUCs may include legal mechanisms (e.g. zoning restrictions, easements, covenants), educational controls (e.g., public notification of residual MEC concerns), and engineering controls (e.g., fencing) to minimize the potential for human exposure to MEC.

1.2 Purpose

The overall purpose of this IA is to provide information on the capability of government agencies associated with the seven MRSs to take part in the implementation and maintenance of LUCs in order to minimize exposure to MEC. The IA will also document existing LUCs

currently in place for the protection of the community from MEC hazards to assist in the evaluation of LUCs during the FS process.

1.3 Hazard Review

Remedial investigations were conducted at each of the seven MRSs listed in **Table 1-1** to determine the nature and extent of MEC as well as the hazards and potential risks posed to human health and the environment by MEC. The remedial investigations concluded that there was no risk from munitions constituent contamination. Only MEC was identified as a potential hazard. The results of these investigations were utilized to develop Munitions and Explosives of Concern Hazard Assessment (MEC HA) Hazard Level and Hazard Scores which are summarized in **Table 1-2**. The data utilized to develop the MEC HA Hazard Level/Scores were presented in remedial investigation reports completed for each of the seven MRSs (Weston, 2014a; 2014b; 2014c; 2014d; 2015).

Table 1-2: Munitions and Explosives of Concern Hazard Assessment Results Summary

MRS	MEC HA Hazard Level	MEC HA Hazard Score
Artillery Firing Range North	1	860
Artillery Firing Range South	3	720
Grey Ghost Housing Area – Undeveloped	3	705
Seacoast Battery	3	620
Siege Battery – Constitution Island	3	690
North Athletic Field	3	595
Target Hill	*	*

* No MEC was identified at the Target Hill MRS (WSTPT-017-R-01); therefore, no MEC HA Hazard Level/Score was developed.

The MEC HA was developed to be utilized during the Comprehensive Environmental Restoration, Compensation, and Liability Act hazard assessment methodology for MRSs where an explosive hazard exists from the known or suspected presence of MEC (United States Environmental Protection Agency [USEPA], 2008). The MEC HA is structured around three components (severity, accessibility, and sensitivity) of a potential explosive hazard incident.

Each of these components was assessed in the MEC HA based on MRS-specific inputs. These inputs were utilized to create a MEC HA Hazard Score from 125 to 1000. The resulting MEC HA Hazard Score corresponds to a MEC HA Hazard Level from 1 to 4. The MEC HA Hazard Levels are summarized below:

- Hazard Level 1 – an MRS with the highest hazard potential. There might be instances where an imminent threat to human health exists from MEC; corresponds to a MEC HA hazard score of 840 to 1000.

The Artillery Firing Range North MRS received a Hazard Score of 860 and was assigned to Hazard Level 1.

- Hazard Level 2 – an MRS with a high hazard potential. An MRS with surface MEC or one undergoing intrusive activities such that MEC would be encountered in the subsurface. The site would also have moderate or greater accessibility by the public.

  No Hazard Level 2 MRSs were identified.

- Hazard Level 3 – an MRS with a moderate hazard potential. An MRS that would be considered safe for the current land use without further munitions responses, although not necessarily suitable for reasonable, anticipated future use. These MRSs would generally have restricted access, a low number of contact hours, and, typically, MEC only in the subsurface.

  The following MRSs were assigned Hazard Level 3: Artillery Firing Range South (Hazard Score of 720), Grey Ghost Housing Area – Undeveloped (Hazard Score of 705), Seacoast Battery (Hazard Score of 620), Siege Battery – Constitution Island (Hazard Score of 690), and North Athletic Field (Hazard Score of 595).

- Hazard Level 4 – An MRS with a low hazard potential. An MRS compatible with current and reasonably anticipated future use. These MRSs typically have had an MEC cleanup performed.

  No Hazard Level 4 MRSs were identified.

No MEC was identified at the Target Hill MRS; however, because munitions debris (MD) was found during investigation activities and undiscovered MEC may be present, the assessment of possible response action alternatives in an FS was recommended for the Target Hill MRS.

1.4 Institution Selection and Discussion

USAG West Point was selected as the sole entity to be evaluated in this IA because each of the seven MRSs are located on a federal military reserve managed by the United States Army Installation Management Command (IMCOM) – Atlantic Region. USAG West Point are further supported by the United States Army Environmental Command (USAEC), a subordinate command of IMCOM, whose mission is, "to lead and execute Army cleanup and environmental quality programs, providing technical expertise to enable soldier readiness, and sustainable military communities."

The following table (**Table 1-3**) summarizes the elements considered when assessing an institution's capacity to assist in the implementation or monitoring of a proposed LUC program.

Table 1-3: U. S. Army Garrison West Point Institutional Analysis

Origin of Institution	USAG West Point role in our nation's history dates back to the Revolutionary War. USAG West Point's mission is "to provide the services, programs, and infrastructure to sustain a community of excellence at West Point."
Basis of Authority	USAG West Point was authorized by the Department of Defense.
Geographic Jurisdiction	USAG West Point has jurisdiction over each of the seven MRSs.
Public Safety Function	It is the responsibility of USAG West Point to prevent or mitigate public safety impacts associated with MEC located at each of the seven MRSs.
Land Use Controls	USAG West Point, as the lead agency, will evaluate and develop the appropriate LUC program for each of the seven MRSs.
Financial Capability	Yes. Funding for the implementation and management of a LUC program for each of the seven MRSs may also be provided by the USAEC.
Desire to Participate	Yes.
Constraints to Institutional Effectiveness	None.

2.0 LAND USE CONTROLS

This section provides a summary of LUC options that are available for each of the seven MRSs. LUCs protect human receptors (e.g., contractor personnel, residents (adults and children), site visitors, etc.) from potential hazards present at the MRSs by warning of potential MEC hazards and/or limiting access to, or use of, the MRS. LUCs may include legal mechanisms, engineering controls, and educational controls.

2.1 Legal Mechanisms

Legal mechanisms limit or control the land use and/or activities that can occur on a property through actions such as restrictive covenants (also known as deed restrictions), easements (e.g., affirmative/negative), zoning restrictions, and permitting programs. The following legal mechanisms may be appropriate for each of the seven MRSs: zoning restrictions, permit programs, siting restrictions, and overlay zoning. Each of these legal mechanisms is further discussed below:

- Zoning Restrictions – used to control land use through the development of zoning ordinances (e.g., residential and commercial/industrial) and master plans.
- Permit Programs – permitting programs, through the permitting agency, determine specific conditions which must be met before a certain use or action is allowed on a property.
- Siting Restrictions – are used to limit land use in areas subject to natural hazards such as earthquakes and floods. This type of control is also used to protect natural resources from development, such as existing wetlands.
- Overlay Zoning – siting restrictions may be combined with zoning ordinances/master plans to establish an effective institutional control. When using overlay zoning, the specific siting restriction is used as an overlay on the local government's master plan, thereby highlighting any discrepancies between the two.

Legal mechanisms are commonly applied to property not owned by the Army; therefore, these general requirements/activities will be identified as administrative mechanisms for each of the seven MRSs because they are located on a federal military reserve managed by IMCOM.

2.2 Engineering Controls

Engineering controls are also known as physical controls and include fencing, signage, and caps. These physical controls may be utilized to limit or prevent human receptor (on-site workers, authorized personnel including residents, and unauthorized trespassers) exposure to MEC at each of the seven MRSs. Fencing, signage, and soil caps are further discussed below:

- Fencing – fencing provides the most direct means of limiting incidental exposure to a contaminated site. By providing access only at certain points, appropriate notice can be given to all users and uses incompatible with the existing site conditions may be avoided.

- Signage – warning signs can provide information regarding the nature of the hazard, how to avoid the hazard, and also provide a contact for additional information. Signs may be used to deter access to a site or to give notice so that inappropriate uses of the site are avoided.
- Caps – placing a cap on a contaminated site by covering it with concrete, asphalt, or soil/clay has been proven to be an effective physical barrier to public exposure to certain types of residual contamination. If the cap is combined with an excavation restriction (administrative mechanism), then such an engineering control could effectively mitigate the risk of receptor contact with MEC.

2.3 Educational Controls

Educational controls include formal education programs and public notices/advisories and are further discussed below:

- Formal Education Programs – educating the local community about the potential exposure risks associated with an MEC contaminated site may be done through a variety of methods. These include periodic classes, training seminars, and training materials. In order to be effective, educational efforts need to be continual so that people do not forget or become complacent about the hazards associated with MEC, as well as to inform newcomers.
- Public Notices – the community can also be educated through the implementation of a wide-ranging public notice campaign that may include mass mailings of brochures, public service announcements on local radio or television stations, or periodic notices in local newspapers.

3.0 EVALUATION OF LAND USE CONTROLS

3.1 Existing Land Use Controls

The *Action Memorandum, Land Use Controls, Military Munitions Response Program* dated June 2012 selected MMRP-specific interim LUCs as the appropriate alternative for the Non-Time-Critical Removal Action (NTCRA) at USAG West Point. These interim LUCs were detailed in the *Non-Time Critical Removal Action, Land Use Control Plan* (LUCP), *Military Munitions Response Program* dated October 2012, and are summarized below in **Table 3-1**.

Table 3-1: Existing Land Use Controls

MRS	Land Use Restriction	Master Plan Notation	Dig Permit	Public Advisories	Monitoring and Enforcement
Artillery Firing Range North	X	X	X	X	X
Artillery Firing Range South	X	X	X	X	X
Grey Ghost Housing Area – Undeveloped	X	X	X	X	X
Seacoast Battery	X	X	X	X	X
Siege Battery – Constitution Island	X	X	X	X	X
North Athletic Field	X	X	X	X	X
Target Hill	X	X	X	X	X

X = selected as an interim LUC.

The LUCs selected for interim implementation include a mixture of administrative mechanisms and educational controls. Engineering controls, including signage, fencing, and guards, were considered during the interim LUC evaluation but were not selected for implementation. The interim LUCs for the seven MRSs are described in greater detail below.

- Land Use Restrictions – use of an MRS for residential purposes, daycare facilities, hospitals, or schools is prohibited without prior approval from USAG West Point. Additionally, excavation activities require a dig permit; dig permits are discussed separately below.
- Master Plan Notation – the installation master plan includes a notation on each MRS to record all 911 calls involving MEC in a geographic information system database to facilitate explosive hazard delineation.
- Dig Permits – dig permits are required whenever ground is broken at each MRS. USAG West Point reviews all dig permits and requires either explosive ordnance disposal (EOD) support or worker training during excavation activities. The determination to use EOD support or worker training is based on the *Interim Probability Assessment for*

Determining the Probability of Encountering MEC during Site Activities at West Point, New York (USAG West Point, 2010) which assigns each MRS to Group A or Group B based on the probability of encountering MEC. Group A MRSs present a low probability and require only worker training, i.e., a safety brochure detailing what actions to take if munitions are encountered and on-call construction support, and Group B MRSs present a moderate to high probability and require on-site construction support for ground disturbing activities.

- Public Advisories – USAG West Point developed an unexploded ordnance (UXO) awareness program to educate various audiences regarding the potential dangers of MEC. Components of the comprehensive UXO awareness program include, brochures (e.g., 3Rs pamphlet) distributed to new residents and annually thereafter, and newspaper and website articles posted quarterly.
- Monitoring and Enforcement – LUCs are reviewed annually by USAG West Point. An annual review report is prepared based on division self-audits, document reviews, site visits, and interviews. The results of the annual review are presented to the Garrison Commander at the installation Environmental Quality Control Committee.

3.2 Potential Land Use Controls

The interim LUCs (administrative mechanisms and educational controls) were evaluated for effectiveness, implementability, and cost utilizing input from USAG West Point and determined to be viable with one exception. The monitoring and enforcement administrative mechanism was modified to remove the annual reporting component and include only an annual review of the LUC program for the purpose of collecting data for use during the Five-Year Review. If engineering controls are selected, then an annual inspection will be performed to maintain the engineering controls. The data, collected annually by USAG West Point, will be utilized during the Five-Year Review to determine the continued protectiveness of the LUC program. Additional engineering controls, including, signage, fencing, and caps, were also evaluated for effectiveness, implementability, and cost utilizing input from USAG West Point. The results of the engineering control evaluation determined that fencing and signage may be viable for implementation at each of the seven MRSs; however, MRS-specific determinations will be made within each FS.

4.0 REFERENCES

URS, 2012. *Action Memorandum, Land Use Controls, Military Munitions Response Program*. Prepared for the USACE and USAG West Point. May.

URS, 2012. *Non-Time Critical Removal Action, Land Use Control Plan, Military Munitions Response Program*. Prepared for the USACE and USAG West Point. October.

U.S. Army, 2009. *Final Munitions Response Remedial Investigation/Feasibility Study Guidance*. November.

USACE, 2000. Engineering Pamphlet 1110-1-24: *Engineering and Design, Establishing and Maintaining Institutional Controls for Ordnance and Explosives (OE) Projects*. December.

USAG West Point, 2010. *Interim Probability Assessment for Determining the Probability of Encountering MEC during Site Activities at West Point, New York*. June.

USEPA, 2008. *Munitions and Explosives of Concern Hazard Assessment Methodology*. USEPA Publication Number: 505B08001. October.

Weston, 2014a. *Final Remedial Investigation Report Seacoast Battery Munitions Response Site.* Prepared for the USACE and USAG West Point. June.

Weston, 2014b. *Final Remedial Investigation Report North Athletic Field Munitions Response Site.* Prepared for the USACE and USAG West Point. June.

Weston, 2014c. *Final Remedial Investigation Report Target Hill Munitions Response Site.* Prepared for the USACE and USAG West Point. June.

Weston, 2014d. *Final Remedial Investigation Report Target Hill Munitions Response Site.* Prepared for the USACE and USAG West Point. October.

Weston, 2015. *Final Remedial Investigation Report for Fort Clinton Munitions Response Site, Siege Battery Munitions Response Site, Lusk Reservoir Munitions Response Site, Artillery Firing Range Munitions Response Site.* Prepared for the USACE and USAG West Point. March.

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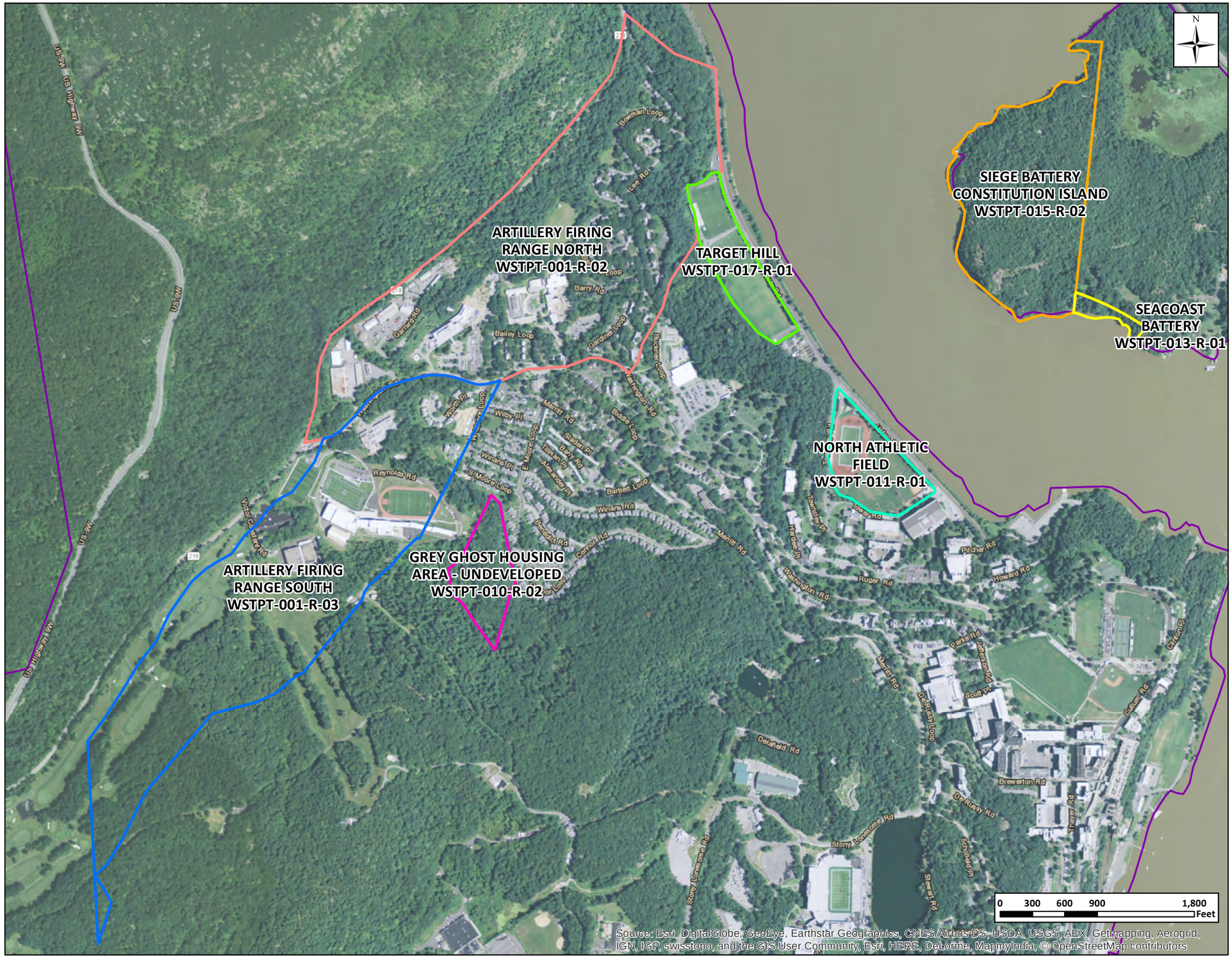

Map Key:

- West Point Boundary
- Artillery Firing Range North
- Artillery Firing Range South
- Grey Ghost Housing Area - Undeveloped
- North Athletic Field
- Seacoast Battery
- Siege Battery Constitution Island
- Target Hill

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Created By: Betsy Bouton
Date: June 2016

FIGURE 1-1

Munitions Response Sites (MRS)

Institutional Analysis
U.S. Army Garrison West Point
West Point, NY

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APPENDIX C
COST ESTIMATES

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Alternative 2: Risk Management
Phase Technology Cost Detail Report (with Markups)

System:

RACER Version: RACER™ Version 11.0.98.0
Database Location: C:\Users\e.rgshare\Documents\RACER\Racer.mdb

Folder:

Folder Name: West_Point

Project:

ID: 8255-5AC
Name: West Point MMRP Feasibility Studies
Category: None

Location
State / Country: NEW YORK
City: WEST POINT MILITARY RESERV

Location Modifier	Default	User	Reason for changes
	1.480	1.480	

Options
Database: Modified System Costs
Cost Database Date: 2012
Report Option: Calendar

Description Includes the development of FSs for seven MRSs located at West Point

Military Reserve in New York.

Site:

ID: WSTPT-015-R-02
Name: Siege Battery - Constitution Island
Type: MMRP

Media/Waste Type

Primary: Ordnance (not residual)
Secondary: Soil

Contaminant

Primary: Ordnance (not residual)
Secondary: Ordnance (residual)

Phase Names

Pre-Study ☐
Study ☐
Design ☐
Removal/Interim Action ☐
Remedial Action ☑
Operations & Maintenance ☐
Long Term Monitoring ☑
Site Closeout ☐

Documentation

Description: 1. Alternative 1: No Action
2. Alternative 2: Risk Management
3. Alternative 3: MEC Removal to Qualify for UU/UE
4. Alternative 4: Partial Surface MEC Removal with Risk Management
5. Alternative 5: Partial Surface/Subsurface MEC Removal with Risk Management
6. Alternative 6: Complete Surface MEC Removal with Risk Management

Support Team: Patrick Reilley: Project Manager
Ali Sadrieh: Program Manager

References: The Remedial Investigation Report (Weston, 2015) and USAG West Point were used to develop the costs included in this report.

Estimator Information

Estimator Name: Jeffrey S. Miller
Estimator Title: Environmental Scientist
Agency/Org./Office: Plexus Scientific Corporation
Business Address: 5510 Cherokee Avenue - Suite 350
Alexandria, VA 22312
Telephone Number: 571.527.1224
Email Address: jmiller@plexsci.com

Estimate Prepared Date: 02/16/2017

Estimator Signature: _____ **Date:** _____

Reviewer Information

Reviewer Name: Jarett McDonald
Reviewer Title: Project Scientist
Agency/Org./Office: Plexus Scientific Corporation
Business Address: 5510 Cherokee Avenue - Suite 350
Alexandria, VA 22312
Telephone Number: 302.547.3876
Email Address: jmcdonald@plexsci.com

Date Reviewed: 02/16/2017

Reviewer Signature: _____ **Date:** _____

Phase Documentation:

Phase Type: Long Term Monitoring
Phase Name: Alt.2: Risk Management
Description: Land Use Controls (administrative mechanisms and educational controls)

Approach: Ex Situ
Start Date: August, 2017
Labor Rate Group: System Labor Rate
Analysis Rate Group: System Analysis Rate

Phase Markup Template: System Defaults

Technology Markups	Markup	% Prime	% Sub.
Land Use Controls	False	0	0
Five-Year Review	False	0	0
Permitting	False	0	0
Construction Support	True	20	80

Total Marked-up Cost: $350,367.59

Technologies:

Technology: Land Use Controls

Element: Planning Docs

	Unit of	Material	Labor	Unit	Equipment	Sub Bid	Cost

Technology: Land Use Controls

Phase	Description	Quantity	Measure	Unit Cost	Cost	Unit Cost	Cost	Extended Cost	Override
33220102	Project Manager	22	HR	0.00	100.83	0.00	0.00	$2,218.20	False
33220105	Project Engineer	30	HR	0.00	84.21	0.00	0.00	$2,526.18	False
33220106	Staff Engineer	45	HR	0.00	112.82	0.00	0.00	$5,076.86	False
33220110	QA/QC Officer	11	HR	0.00	93.15	0.00	0.00	$1,024.68	False
33220114	Word Processing/Clerical	60	HR	0.00	50.28	0.00	0.00	$3,016.97	False
33220115	Draftsman/CADD	30	HR	0.00	53.92	0.00	0.00	$1,617.62	False
33220503	Attorney, Partner, Real Estate	22	HR	0.00	358.18	0.00	0.00	$7,879.92	False
33240101	Other Direct Costs	1	LS	584.01	0.00	0.00	0.00	$584.01	True

Total Element Cost: $23,944.43

Element: Planning Meetings

Phase	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Cost	Extended Cost	Cost Override
33010104	Vehicle mileage charge, car or van	10	MI	0.00	0.00	0.00	0.51	$5.10	True
33010202	Per Diem (per person)	1	DAY	0.00	0.00	0.00	160.00	$160.00	True
33220102	Project Manager	21	HR	0.00	100.83	0.00	0.00	$2,117.37	False
33220114	Word Processing/Clerical	16	HR	0.00	50.28	0.00	0.00	$804.53	False
33220115	Draftsman/CADD	8	HR	0.00	53.92	0.00	0.00	$431.36	False
33240101	Other Direct Costs	1	LS	83.83	0.00	0.00	0.00	$83.83	True

Total Element Cost: $3,602.19

Technology: Land Use Controls

Element: Implementation

Phase	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Cost	Extended Cost	Cost Override
33022037	Overnight Delivery, 8 oz Letter	8	EA	0.00	0.00	0.00	26.85	$214.78	False
33040671	Portable GPS Set with Mapping, 5 cm Accuracy	1	MO	3,537.20	0.00	0.00	0.00	$3,537.20	False
33220102	Project Manager	30	HR	0.00	100.83	0.00	0.00	$3,024.81	False
33220105	Project Engineer	45	HR	0.00	84.21	0.00	0.00	$3,789.27	False
33220106	Staff Engineer	60	HR	0.00	112.82	0.00	0.00	$6,769.15	False
33220110	QA/QC Officer	13	HR	0.00	93.15	0.00	0.00	$1,210.99	False
33220114	Word Processing/Clerical	30	HR	0.00	50.28	0.00	0.00	$1,508.49	False
33220115	Draftsman/CADD	90	HR	0.00	53.92	0.00	0.00	$4,852.85	False
33220212	Surveying - 2-man Crew	3	DAY	0.00	1,421.64	20.96	0.00	$4,327.80	False
33240101	Other Direct Costs	1	LS	635.51	0.00	0.00	0.00	$635.51	True

Total Element Cost: $29,870.84

Element: Monitoring & Enforcement

Phase	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Cost	Extended Cost	Cost Override
33010104	Vehicle mileage charge, car or van	15	MI	0.00	0.00	0.00	0.51	$7.65	True
33010202	Per Diem (per person)	2	DAY	0.00	0.00	0.00	160.00	$320.00	True
33220102	Project Manager	13	HR	0.00	100.83	0.00	0.00	$1,310.75	False
33220114	Word Processing/Clerical	1	HR	0.00	50.28	0.00	0.00	$50.28	False

Technology: Land Use Controls

33240101	Other Direct Costs	1	LS	34.03	0.00	0.00	0.00	$34.03	True

Total Element Cost: $1,722.71

Total 1st Year Tech Cost: $59,140.18

Technology: Five-Year Review

Element: Document Review

Phase	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Cost	Extended Cost	Cost Override
33220105	Project Engineer	2	HR	0.00	102.69	0.00	0.00	$205.38	False
33220108	Project Scientist	1	HR	0.00	113.60	0.00	0.00	$113.60	False
33220109	Staff Scientist	2	HR	0.00	65.76	0.00	0.00	$131.51	False

Total Element Cost: $450.49

Element: Site Inspection

Phase	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Cost	Extended Cost	Cost Override
33220102	Project Manager	2	HR	0.00	122.96	0.00	0.00	$245.92	False
33220105	Project Engineer	2	HR	0.00	102.69	0.00	0.00	$205.38	False
33220108	Project Scientist	2	HR	0.00	113.60	0.00	0.00	$227.20	False
33220109	Staff Scientist	2	HR	0.00	65.76	0.00	0.00	$131.51	False

					Total Element Cost:			$810.02	

Element: Report

Phase	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Cost	Extended Cost	Cost Override
33220102	Project Manager	6	HR	0.00	122.96	0.00	0.00	$737.76	False
33220105	Project Engineer	16	HR	0.00	102.69	0.00	0.00	$1,643.04	False
33220108	Project Scientist	13	HR	0.00	113.60	0.00	0.00	$1,476.81	False
33220109	Staff Scientist	26	HR	0.00	65.76	0.00	0.00	$1,709.68	False

					Total Element Cost:			$5,567.29	
					Total 1st Year Tech Cost:			$6,827.80	

Technology: Permitting

Element:

Phase	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Cost	Extended Cost	Cost Override
33220105	Project Engineer	2	HR	0.00	102.69	0.00	0.00	$205.38	False

					Total Element Cost:			$205.38	
					Total 1st Year Tech Cost:			$205.38	

Technology: Construction Support

Element:

Technology: Construction Support

Phase	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Cost	Extended Cost	Cost Override
33010108	Sedan, Automobile, Rental	10	DAY	0.00	0.00	0.00	94.57	$945.66	False
33010202	Per Diem (per person)	64	DAY	0.00	0.00	0.00	116.00	$7,424.00	True
33040213	White's All Metals, weekly rental	32	WK	0.00	0.00	0.00	359.64	$11,508.48	True
33040651	4 X 4 Truck- Rental/Lease	10	DAY	0.00	0.00	167.27	0.00	$1,672.74	False
33040921	Senior UXO Supervisor (SUXOS)	100	HR	0.00	113.39	0.00	0.00	$11,338.89	False
33040923	UXO Project Manager	100	HR	0.00	166.81	0.00	0.00	$16,680.94	False
33040930	UXO QC Specialist	100	HR	0.00	104.09	0.00	0.00	$10,409.21	False
33040931	UXO Safety Officer	100	HR	0.00	105.70	0.00	0.00	$10,570.21	False
33040934	UXO Technician II	100	HR	0.00	78.42	0.00	0.00	$7,842.36	False
33041001	16oz Standard TNT Booster	8	EA	0.92	0.00	0.00	0.00	$7.36	False
33041002	50 gr/ft Det -Cord (1000 ft roll)	2	EA	1,144.46	0.00	0.00	0.00	$2,288.93	False
33041004	12 ft Lead Primadet Non- Electric Detonators	4	EA	13.73	0.00	0.00	0.00	$54.93	False
33041101	Airfare	10	LS	0.00	0.00	0.00	0.00	$0.00	False
33041301	Site Specific Workplan (Low Complexity)	2	EA	200.58	26,873.59	0.00	0.00	$54,148.33	False
33041304	Explosive Safety Submission (Low Complexity)	2	EA	401.15	8,628.45	0.00	0.00	$18,059.21	False
33041313	UXO Removal Report (Low Complexity)	2	EA	200.58	27,647.36	0.00	0.00	$55,695.87	False

Total Element Cost:	$208,647.13
Total 1st Year Tech Cost:	$208,647.13

	Total Phase Element Cost	**$274,820.49**

Alternative 2: Risk Management
Phase Cost Over Time Report (with Markups)

System:

RACER Version: RACER™ Version 11.0.98.0
Database Location: C:\Users\e.rgshare\Documents\RACER\Racer.mdb

Folder:

Folder Name: West_Point

Project:

ID: 8255-5AC
Name: West Point MMRP Feasibility Studies
Category: None

Location
State / Country: NEW YORK
City: WEST POINT MILITARY RESERV

Location Modifier	Default	User	Reason for changes
	1.480	1.480	

Options
Database: Modified System Costs
Cost Database Date: 2012
Report Option: Calendar

Description Includes the development of FSs for seven MRSs located at West Point Military Reserve in New York.

Site:

ID: WSTPT-015-R-02
Name: Siege Battery - Constitution Island
Type: MMRP

Media/Waste Type

Primary: Ordnance (not residual)
Secondary: Soil

Contaminant

Primary: Ordnance (not residual)
Secondary: Ordnance (residual)

Phase Names

Pre-Study ☐
Study ☐
Design ☐
Removal/Interim Action ☐
Remedial Action ☑
Operations & Maintenance ☐
Long Term Monitoring ☑
Site Closeout ☐

Documentation

Description: 1. Alternative 1: No Action
2. Alternative 2: Risk Management
3. Alternative 3: MEC Removal to Qualify for UU/UE
4. Alternative 4: Partial Surface MEC Removal with Risk Management
5. Alternative 5: Partial Surface/Subsurface MEC Removal with Risk Management
6. Alternative 6: Complete Surface MEC Removal with Risk Management

Support Team: Patrick Reilley: Project Manager
Ali Sadrieh: Program Manager

References: The Remedial Investigation Report (Weston, 2015) and USAG West Point were used to develop the costs included in this report.

Estimator Information

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Estimator Title: Environmental Scientist
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Alexandria, VA 22312
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Estimate Prepared Date: 02/16/2017

Estimator Signature: _____ **Date:** _____

Reviewer Information

Reviewer Name: Jarett McDonald
Reviewer Title: Project Scientist
Agency/Org./Office: Plexus Scientific Corporation
Business Address: 5510 Cherokee Avenue - Suite 350
Alexandria, VA 22312
Telephone Number: 302.547.3876
Email Address: jmcdonald@plexsci.com

Date Reviewed: 02/16/2017

Reviewer Signature: _____ **Date:** _____

Technology Name	Technology	2017	2018	2019	2020	2021	2022
Construction Support	1	$0	$0	$0	$0	$0	$0
Five-Year Review	1	$0	$0	$0	$0	$0	$6,828
Land Use Controls	1	$57,417	$1,723	$1,723	$1,723	$1,723	$1,723
Permitting	1	$0	$0	$0	$0	$0	$0
Total Phase Cost		$57,417	$1,723	$1,723	$1,723	$1,723	$8,551

Technology Name	Technology	2023	2024	2025	2026	2027	2028
Construction Support	1	$0	$0	$0	$0	$0	$0
Five-Year Review	1	$0	$0	$0	$0	$6,828	$0
Land Use Controls	1	$1,723	$1,723	$1,723	$1,723	$1,723	$1,723
Permitting	1	$0	$0	$0	$0	$0	$0
Total Phase Cost		$1,723	$1,723	$1,723	$1,723	$8,551	$1,723

Technology Name	Technology	2029	2030	2031	2032	2033	2034
Construction Support	1	$0	$0	$104,324	$0	$0	$0
Five-Year Review	1	$0	$0	$0	$6,828	$0	$0
Land Use Controls	1	$1,723	$1,723	$1,723	$1,723	$1,723	$1,723
Permitting	1	$0	$0	$103	$0	$0	$0
Total Phase Cost		$1,723	$1,723	$106,150	$8,551	$1,723	$1,723

Technology Name	Technology	2035	2036	2037	2038	2039	2040
Construction Support	1	$0	$0	$0	$0	$0	$0
Five-Year Review	1	$0	$0	$6,828	$0	$0	$0
Land Use Controls	1	$1,723	$1,723	$1,723	$1,723	$1,723	$1,723
Permitting	1	$0	$0	$0	$0	$0	$0
Total Phase Cost		$1,723	$1,723	$8,551	$1,723	$1,723	$1,723

Technology Name	Technology	2041	2042	2043	2044	2045	2046
Construction Support	1	$0	$0	$0	$0	$0	$104,324
Five-Year Review	1	$0	$6,828	$0	$0	$0	$0
Land Use Controls	1	$1,723	$1,723	$1,723	$1,723	$1,723	$1,723
Permitting	1	$0	$0	$0	$0	$0	$103
Total Phase Cost		$1,723	$8,551	$1,723	$1,723	$1,723	$106,150

Technology Name	Technology	Total					
Construction Support	1	$208,647					
Five-Year Review	1	$34,139					
Land Use Controls	1	$107,376					
Permitting	1	$205					
Total Phase Cost		$350,368	$0	$0	$0	$0	$0

Alternative 3: MEC Removal to Qualify for UU/UE Phase Technology Cost Detail Report (with Markups)

System:

RACER Version: RACER™ Version 11.0.98.0
Database Location: C:\Users\e.rgshare\Documents\RACER\Racer.mdb

Folder:

Folder Name: West_Point

Project:

ID: 8255-5AC
Name: West Point MMRP Feasibility Studies
Category: None

Location
State / Country: NEW YORK
City: WEST POINT MILITARY RESERV

Location Modifier	Default	User	Reason for changes
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Options
Database: Modified System Costs
Cost Database Date: 2012
Report Option: Calendar

Description Includes the development of FSs for seven MRSs located at West Point

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Study ☐
Design ☐
Removal/Interim Action ☐
Remedial Action ☑
Operations & Maintenance ☐
Long Term Monitoring ☑
Site Closeout ☐

Documentation

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2. Alternative 2: Risk Management
3. Alternative 3: MEC Removal to Qualify for UU/UE
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Support Team: Patrick Reilley: Project Manager
Ali Sadrieh: Program Manager

References: The Remedial Investigation Report (Weston, 2015) and USAG West Point were used to develop the costs included in this report.

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Telephone Number: 302.547.3876
Email Address: jmcdonald@plexsci.com

Date Reviewed: 02/16/2017

Reviewer Signature: _____ **Date:** _____

Phase Documentation:

Phase Type: Remedial Action
Phase Name: Alt.3: MEC Removal to Qualify for UU/UE
Description: Removal of surface/subsurface MEC from the 52-acre MRS.

Approach: Ex Situ
Start Date: August, 2017
Labor Rate Group: System Labor Rate
Analysis Rate Group: System Analysis Rate

Phase Markup Template: System Defaults

Technology Markups	Markup	% Prime	% Sub.
Clear and Grub	True	20	80
MEC Removal Action	True	20	80
Cleanup and Landscaping	True	100	0

Total Marked-up Cost: $4,524,799.46

Technologies:

Technology: Clear and Grub

Element:

Phase	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Cost	Extended Cost	Cost Override

Technology: Clear and Grub

17010112	Clear trees, wet conditions, heavy growth, 200 H.P. dozer, excludes grubbing	2	ACR	0.00	4,578.10	352.51	0.00	$11,044.57	False
17010210	Site clearing trees, with 335 H.P. dozer, to 6" diameter	5,200	EA	0.00	6.74	8.55	0.00	$79,504.29	False
17010211	Site clearing trees, with 335 H.P. dozer, to 12" diameter	1,300	EA	0.00	12.58	15.96	0.00	$37,101.48	False
17010310	Remove stumbs, wet conditions, with dozer, to 6" diameter	224	EA	0.00	94.37	104.41	0.00	$44,526.82	False
17010311	Remove stumbs, wet conditions, with dozer, 6" to 12" diameter	56	EA	0.00	117.96	130.51	0.00	$13,914.62	False
17010314	Grub stumps, with 335 H.P. dozer, to 6" diameter	4,977	EA	0.00	4.72	5.98	0.00	$53,265.32	False
17010315	Grub stumps, with 335 H.P. dozer, to 12" diameter	1,245	EA	0.00	7.55	12.71	0.00	$25,228.10	False
17010403	Chipping brush, heavy brush	52	ACR	0.00	7,547.64	1,781.21	0.00	$485,100.47	False
17010501	Grub and stack, 140 H.P. dozer	10,216	CY	0.00	7.55	3.99	0.00	$117,875.91	False
17030226	988, 7.0 CY, Wheel Loader	88	HR	0.00	168.17	238.68	0.00	$35,802.73	False
17030296	50 Ton, 773, Off-highway Truck	177	HR	0.00	156.52	322.07	0.00	$84,709.14	False
33010118	Mobilize/Demobilize Dozer, Loader, Backhoe or Excavator, 70 H.P. to 150 H.P., up to 50 miles	4	LS	0.00	313.03	226.09	0.00	$2,156.49	False
33029501	Shipping	2	LS	79.72	0.00	0.00	0.00	$159.44	False
33040213	White's All Metals, weekly rental	9	WK	0.00	0.00	0.00	359.64	$3,236.76	False
33040934	UXO Technician II	360	HR	0.00	95.64	0.00	0.00	$34,429.86	False

Total Element Cost: $1,028,055.99

Total 1st Year Tech Cost:	$1,028,055.99

Technology: MEC Removal Action

Element: Site Visit

Phase	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Cost	Extended Cost	Cost Override
33010108	Sedan, Automobile, Rental	3	DAY	0.00	0.00	0.00	94.57	$283.70	False
33010202	Per Diem (per person)	9	DAY	0.00	0.00	0.00	160.00	$1,440.00	True
33040921	Senior UXO Supervisor (SUXOS)	40	HR	0.00	138.28	0.00	0.00	$5,531.17	False
33040923	UXO Project Manager	40	HR	0.00	203.43	0.00	0.00	$8,137.04	False
33040925	UXO Staff Engineer	40	HR	0.00	129.72	0.00	0.00	$5,188.66	False
33041101	Airfare	3	LS	0.00	0.00	0.00	750.00	$2,250.00	True
33240101	Other Direct Costs	1	LS	797.20	0.00	0.00	0.00	$797.20	True

Total Element Cost:	$23,627.77

Element: Surveying

Phase	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Cost	Extended Cost	Cost Override
33010202	Per Diem (per person)	10	DAY	0.00	0.00	0.00	160.00	$1,600.00	True
33040670	Hand Held GPS Unit, Battery Powered	3	EA	848.32	0.00	0.00	0.00	$2,544.96	False
33040671	Portable GPS Set with Mapping, 5 cm Accuracy	1	MO	5,639.73	0.00	0.00	0.00	$5,639.73	False
33040935	UXO Technician III (UXO Supervisor)	70	HR	0.00	112.46	0.00	0.00	$7,872.03	False
33041101	Airfare	1	LS	0.00	0.00	0.00	750.00	$750.00	True

Technology: MEC Removal Action

33220213	Surveying - 3-man Crew	7	DAY	0.00	3,940.00	33.41	0.00	$27,813.92	False
33240101	Other Direct Costs	1	LS	1,352.18	0.00	0.00	0.00	$1,352.18	True

Total Element Cost: $47,572.80

Element: UXO Mapping

Phase	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Cost	Extended Cost	Cost Override
33010202	Per Diem (per person)	1,911	DAY	0.00	0.00	0.00	160.00	$305,760.00	True
33021530	Differential GPS Unit Rental	3	MO	469.98	0.00	0.00	0.00	$1,409.93	False
33040210	Geonics EM-61 Metal Locator, Towed (Weekly Rental)	4	WK	0.00	0.00	0.00	788.94	$3,155.75	False
33040213	White's All Metals, weekly rental	216	WK	0.00	0.00	0.00	359.64	$77,682.24	True
33040651	4 X 4 Truck- Rental/Lease	553	DAY	0.00	0.00	167.27	0.00	$92,502.41	False
33040653	All Terrain Vehicle (ATV) - Rental/Lease	3	DAY	0.00	0.00	0.00	319.36	$958.08	False
33040670	Hand Held GPS Unit, Battery Powered	1	EA	848.32	0.00	0.00	0.00	$848.32	False
33040934	UXO Technician II	8,640	HR	0.00	95.64	0.00	0.00	$826,316.69	False
33040935	UXO Technician III (UXO Supervisor)	1,720	HR	0.00	112.46	0.00	0.00	$193,426.97	False
33040936	Geophysicist (UXO)	280	HR	0.00	183.39	0.00	0.00	$51,349.30	False
33041101	Airfare	20	LS	0.00	0.00	0.00	750.00	$15,000.00	True
33240101	Other Direct Costs	1	LS	61,979.27	0.00	0.00	0.00	$61,979.27	True

Total Element Cost: $1,630,388.96

Element: UXO Removal

Phase	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Cost	Extended Cost	Cost Override
33010202	Per Diem (per person)	45	DAY	0.00	0.00	0.00	160.00	$7,200.00	True
33040149	Nonsparking UXO Shovels	14	EA	122.59	0.00	0.00	0.00	$1,716.22	False
33040213	White's All Metals, weekly rental	6	WK	0.00	0.00	0.00	359.64	$2,157.84	True
33040646	Backhoe - Rental/Lease	6	DAY	0.00	0.00	597.66	0.00	$3,585.97	False
33040651	4 X 4 Truck- Rental/Lease	14	DAY	0.00	0.00	167.27	0.00	$2,341.83	False
33040934	UXO Technician II	180	HR	0.00	95.64	0.00	0.00	$17,214.93	False
33040935	UXO Technician III (UXO Supervisor)	50	HR	0.00	112.46	0.00	0.00	$5,622.88	False
33040936	Geophysicist (UXO)	40	HR	0.00	183.39	0.00	0.00	$7,335.61	False
33041001	16oz Standard TNT Booster	6	EA	0.92	0.00	0.00	0.00	$5.52	False
33041002	50 gr/ft Det -Cord (1000 ft roll)	1	EA	1,144.46	0.00	0.00	0.00	$1,144.46	False
33041004	12 ft Lead Primadet Non- Electric Detonators	3	EA	13.73	0.00	0.00	0.00	$41.20	False
33240101	Other Direct Costs	1	LS	1,995.02	0.00	0.00	0.00	$1,995.02	True

Total Element Cost: $50,361.49

Element: Site Management

Phase	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Cost	Extended Cost	Cost Override
33010202	Per Diem (per person)	676	DAY	0.00	0.00	0.00	160.00	$108,160.00	True
33040651	4 X 4 Truck- Rental/Lease	679	DAY	0.00	0.00	167.27	0.00	$113,578.91	False
33040921	Senior UXO Supervisor (SUXOS)	970	HR	0.00	138.28	0.00	0.00	$134,130.81	False

Technology: MEC Removal Action

33040923	UXO Project Manager	970	HR	0.00	203.43	0.00	0.00	$197,323.32	False
33040930	UXO QC Specialist	970	HR	0.00	126.94	0.00	0.00	$123,133.35	False
33040931	UXO Safety Officer	970	HR	0.00	128.91	0.00	0.00	$125,037.91	False
33041101	Airfare	4	LS	0.00	0.00	0.00	750.00	$3,000.00	True

Total Element Cost: $804,364.30

Element: Stakeholder Involvement

Phase	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Cost	Extended Cost	Cost Override
33040923	UXO Project Manager	16	HR	0.00	203.43	0.00	0.00	$3,254.82	False
33040935	UXO Technician III (UXO Supervisor)	16	HR	0.00	112.46	0.00	0.00	$1,799.32	False
33041303	Site Specific Workplan (High Complexity)	1	EA	200.58	57,523.92	0.00	0.00	$57,724.49	False
33041306	Explosive Safety Submission (High Complexity)	1	EA	401.15	30,045.69	0.00	0.00	$30,446.85	False
33041315	UXO Removal Report (High Complexity)	1	EA	601.73	76,518.01	0.00	0.00	$77,119.74	False

Total Element Cost: $170,345.22

Total 1st Year Tech Cost: $2,726,660.55

Technology: Cleanup and Landscaping

Element:

Technology: Cleanup and Landscaping

Phase	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Cost	Extended Cost	Cost Override
18050101	Area Preparation, 67% Level & 33% Slope	52	ACR	0.00	44.35	49.07	0.00	$4,857.70	False
18050401	Seeding, 67% Level & 33% Slope, Hydroseeding	52	ACR	4,540.51	1,884.00	1,319.33	0.00	$402,679.41	False
18050408	Fertilizer, Hydro Spread	104	ACR	231.86	182.02	60.70	0.00	$49,355.72	False
18050413	Watering with 3,000-Gallon Tank Truck, per Pass	416	ACR	408.33	102.52	97.67	0.00	$253,142.89	False
18050415	Mowing	104	ACR	0.00	577.38	0.00	0.00	$60,047.21	False

Total Element Cost:	$770,082.92
Total 1st Year Tech Cost:	$770,082.92
Total Phase Element Cost	**$4,524,799.46**

Alternative 3: MEC Removal to Qualify for UU/UE
Phase Cost Over Time Report (with Markups)

System:

RACER Version: RACER™ Version 11.0.98.0
Database Location: C:\Users\e.rgshare\Documents\RACER\Racer.mdb

Folder:

Folder Name: West_Point

Project:

ID: 8255-5AC
Name: West Point MMRP Feasibility Studies
Category: None

Location
State / Country: NEW YORK
City: WEST POINT MILITARY RESERV

Location Modifier	Default	User	Reason for changes
	1.480	1.480	

Options
Database: Modified System Costs
Cost Database Date: 2012
Report Option: Calendar

Description Includes the development of FSs for seven MRSs located at West Point Military Reserve in New York.

Site:

ID: WSTPT-015-R-02
Name: Siege Battery - Constitution Island
Type: MMRP

Media/Waste Type

Primary: Ordnance (not residual)
Secondary: Soil

Contaminant

Primary: Ordnance (not residual)
Secondary: Ordnance (residual)

Phase Names

Pre-Study ☐
Study ☐
Design ☐
Removal/Interim Action ☐
Remedial Action ☑
Operations & Maintenance ☐
Long Term Monitoring ☑
Site Closeout ☐

Documentation

Description: 1. Alternative 1: No Action
2. Alternative 2: Risk Management
3. Alternative 3: MEC Removal to Qualify for UU/UE
4. Alternative 4: Partial Surface MEC Removal with Risk Management
5. Alternative 5: Partial Surface/Subsurface MEC Removal with Risk Management
6. Alternative 6: Complete Surface MEC Removal with Risk Management

Support Team: Patrick Reilley: Project Manager
Ali Sadrieh: Program Manager

References: The Remedial Investigation Report (Weston, 2015) and USAG West Point were used to develop the costs included in this report.

Estimator Information

Estimator Name: Jeffrey S. Miller
Estimator Title: Environmental Scientist
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Alexandria, VA 22312
Telephone Number: 571.527.1224
Email Address: jmiller@plexsci.com

Estimate Prepared Date: 02/16/2017

Estimator Signature: _____ **Date:** _____

Reviewer Information

Reviewer Name: Jarett McDonald
Reviewer Title: Project Scientist
Agency/Org./Office: Plexus Scientific Corporation
Business Address: 5510 Cherokee Avenue - Suite 350
Alexandria, VA 22312
Telephone Number: 302.547.3876
Email Address: jmcdonald@plexsci.com

Date Reviewed: 02/16/2017

Reviewer Signature: _____ **Date:** _____

Technology Name	Technology	2017	Total				
Cleanup and Landscaping	1	$770,083	$770,083				
Clear and Grub	1	$1,028,056	$1,028,056				
MEC Removal Action	1	$2,726,661	$2,726,661				
Total Phase Cost		$4,524,799	$4,524,799	$0	$0	$0	$0

Alternative 4: Partial Surface MEC Removal with Risk Management
Phase Technology Cost Detail Report (with Markups)

System:

RACER Version: RACER™ Version 11.0.98.0
Database Location: C:\Users\e.rgshare\Documents\RACER\Racer.mdb

Folder:

Folder Name: West_Point

Project:

ID: 8255-5AC
Name: West Point MMRP Feasibility Studies
Category: None

Location
State / Country: NEW YORK
City: WEST POINT MILITARY RESERV

Location Modifier	Default	User	Reason for changes
	1.480	1.480	

Options
Database: Modified System Costs
Cost Database Date: 2012
Report Option: Calendar

Description Includes the development of FSs for seven MRSs located at West Point

Military Reserve in New York.

Site:

ID: WSTPT-015-R-02
Name: Siege Battery - Constitution Island
Type: MMRP

Media/Waste Type

Primary: Ordnance (not residual)
Secondary: Soil

Contaminant

Primary: Ordnance (not residual)
Secondary: Ordnance (residual)

Phase Names

- **Pre-Study** ☐
- **Study** ☐
- **Design** ☐
- **Removal/Interim Action** ☐
- **Remedial Action** ☑
- **Operations & Maintenance** ☐
- **Long Term Monitoring** ☑
- **Site Closeout** ☐

Documentation

Description:
1. Alternative 1: No Action
2. Alternative 2: Risk Management
3. Alternative 3: MEC Removal to Qualify for UU/UE
4. Alternative 4: Partial Surface MEC Removal with Risk Management
5. Alternative 5: Partial Surface/Subsurface MEC Removal with Risk Management
6. Alternative 6: Complete Surface MEC Removal with Risk Management

Support Team: Patrick Reilley: Project Manager
Ali Sadrieh: Program Manager

References: The Remedial Investigation Report (Weston, 2015) and USAG West Point were used to develop the costs included in this report.

Estimator Information

Estimator Name: Jeffrey S. Miller
Estimator Title: Environmental Scientist
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Estimate Prepared Date: 02/16/2017

Estimator Signature: _____ **Date:** _____

Reviewer Information

Reviewer Name: Jarett McDonald
Reviewer Title: Project Scientist
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Alexandria, VA 22312
Telephone Number: 302.547.3876
Email Address: jmcdonald@plexsci.com

Date Reviewed: 02/16/2017

Reviewer Signature: _____ **Date:** _____

Phase Documentation:

Phase Type: Remedial Action
Phase Name: Alt.4: Partial Surface MEC Removal with RM
Description: Removal of surface MEC from the 10-acre area followed by LUC (administrative mechanisms and educational controls) implementation across the entire MRS (52 acres).
Approach: Ex Situ
Start Date: August, 2017
Labor Rate Group: System Labor Rate
Analysis Rate Group: System Analysis Rate
Phase Markup Template: System Defaults

Technology Markups	Markup	% Prime	% Sub.
Construction Support	True	20	80
Land Use Controls	False	0	0
Five-Year Review	False	0	0
Permitting	False	0	0
MEC Removal Action	True	20	80

Total Marked-up Cost: $945,072.49

Technologies:

Technology: Land Use Controls

Technology: Land Use Controls

Element: Planning Docs

Phase	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Cost	Extended Cost	Cost Override
33220102	Project Manager	22	HR	0.00	100.83	0.00	0.00	$2,218.20	False
33220105	Project Engineer	30	HR	0.00	84.21	0.00	0.00	$2,526.18	False
33220106	Staff Engineer	45	HR	0.00	112.82	0.00	0.00	$5,076.86	False
33220110	QA/QC Officer	11	HR	0.00	93.15	0.00	0.00	$1,024.68	False
33220114	Word Processing/Clerical	60	HR	0.00	50.28	0.00	0.00	$3,016.97	False
33220115	Draftsman/CADD	30	HR	0.00	53.92	0.00	0.00	$1,617.62	False
33220503	Attorney, Partner, Real Estate	22	HR	0.00	358.18	0.00	0.00	$7,879.92	False
33240101	Other Direct Costs	1	LS	584.01	0.00	0.00	0.00	$584.01	True

Total Element Cost: $23,944.43

Element: Planning Meetings

Phase	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Cost	Extended Cost	Cost Override
33010104	Vehicle mileage charge, car or van	10	MI	0.00	0.00	0.00	0.51	$5.10	True
33010202	Per Diem (per person)	1	DAY	0.00	0.00	0.00	160.00	$160.00	True
33220102	Project Manager	21	HR	0.00	100.83	0.00	0.00	$2,117.37	False
33220114	Word Processing/Clerical	16	HR	0.00	50.28	0.00	0.00	$804.53	False
33220115	Draftsman/CADD	8	HR	0.00	53.92	0.00	0.00	$431.36	False
33240101	Other Direct Costs	1	LS	83.83	0.00	0.00	0.00	$83.83	True

Total Element Cost: $3,602.19

Element: Implementation

Phase	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Cost	Extended Cost	Cost Override
33022037	Overnight Delivery, 8 oz Letter	8	EA	0.00	0.00	0.00	26.85	$214.78	False
33040671	Portable GPS Set with Mapping, 5 cm Accuracy	1	MO	3,537.20	0.00	0.00	0.00	$3,537.20	False
33220102	Project Manager	30	HR	0.00	100.83	0.00	0.00	$3,024.81	False
33220105	Project Engineer	45	HR	0.00	84.21	0.00	0.00	$3,789.27	False
33220106	Staff Engineer	60	HR	0.00	112.82	0.00	0.00	$6,769.15	False
33220110	QA/QC Officer	13	HR	0.00	93.15	0.00	0.00	$1,210.99	False
33220114	Word Processing/Clerical	30	HR	0.00	50.28	0.00	0.00	$1,508.49	False
33220115	Draftsman/CADD	90	HR	0.00	53.92	0.00	0.00	$4,852.85	False
33220212	Surveying - 2-man Crew	3	DAY	0.00	1,421.64	20.96	0.00	$4,327.80	False
33240101	Other Direct Costs	1	LS	635.51	0.00	0.00	0.00	$635.51	True

Total Element Cost: $29,870.84

Element: Monitoring & Enforcement

Phase	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Cost	Extended Cost	Cost Override
33010104	Vehicle mileage charge, car or van	15	MI	0.00	0.00	0.00	0.51	$7.65	True
33010202	Per Diem (per person)	2	DAY	0.00	0.00	0.00	160.00	$320.00	True
33220102	Project Manager	13	HR	0.00	100.83	0.00	0.00	$1,310.75	False
33220114	Word Processing/Clerical	1	HR	0.00	50.28	0.00	0.00	$50.28	False

Technology: Land Use Controls

33240101	Other Direct Costs	1	LS	34.03	0.00	0.00	0.00	$34.03	True

Total Element Cost: $1,722.71

Total 1st Year Tech Cost: $59,140.18

Technology: Five-Year Review

Element: Document Review

Phase	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Cost	Extended Cost	Cost Override
33220105	Project Engineer	2	HR	0.00	102.69	0.00	0.00	$205.38	False
33220108	Project Scientist	1	HR	0.00	113.60	0.00	0.00	$113.60	False
33220109	Staff Scientist	2	HR	0.00	65.76	0.00	0.00	$131.51	False

Total Element Cost: $450.49

Element: Site Inspection

Phase	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Cost	Extended Cost	Cost Override
33220102	Project Manager	2	HR	0.00	122.96	0.00	0.00	$245.92	False
33220105	Project Engineer	2	HR	0.00	102.69	0.00	0.00	$205.38	False
33220108	Project Scientist	2	HR	0.00	113.60	0.00	0.00	$227.20	False
33220109	Staff Scientist	2	HR	0.00	65.76	0.00	0.00	$131.51	False

					Total Element Cost:			$810.02	

Element: Report

Phase	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Cost	Extended Cost	Cost Override
33220102	Project Manager	6	HR	0.00	122.96	0.00	0.00	$737.76	False
33220105	Project Engineer	16	HR	0.00	102.69	0.00	0.00	$1,643.04	False
33220108	Project Scientist	13	HR	0.00	113.60	0.00	0.00	$1,476.81	False
33220109	Staff Scientist	26	HR	0.00	65.76	0.00	0.00	$1,709.68	False

					Total Element Cost:			$5,567.29	
					Total 1st Year Tech Cost:			$6,827.80	

Technology: Permitting

Element:

Phase	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Cost	Extended Cost	Cost Override
33220105	Project Engineer	2	HR	0.00	102.69	0.00	0.00	$205.38	False

					Total Element Cost:			$205.38	
					Total 1st Year Tech Cost:			$205.38	

Technology: MEC Removal Action

Element: Site Visit

Technology: MEC Removal Action

Phase	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Cost	Extended Cost	Cost Override
33010108	Sedan, Automobile, Rental	3	DAY	0.00	0.00	0.00	94.57	$283.70	False
33010202	Per Diem (per person)	9	DAY	0.00	0.00	0.00	160.00	$1,440.00	True
33040921	Senior UXO Supervisor (SUXOS)	40	HR	0.00	138.28	0.00	0.00	$5,531.17	False
33040923	UXO Project Manager	40	HR	0.00	203.43	0.00	0.00	$8,137.04	False
33040925	UXO Staff Engineer	40	HR	0.00	129.72	0.00	0.00	$5,188.66	False
33041101	Airfare	3	LS	0.00	0.00	0.00	750.00	$2,250.00	True
33240101	Other Direct Costs	1	LS	797.20	0.00	0.00	0.00	$797.20	True

Total Element Cost: $23,627.77

Element: Surveying

Phase	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Cost	Extended Cost	Cost Override
33010202	Per Diem (per person)	2	DAY	0.00	0.00	0.00	160.00	$320.00	True
33040935	UXO Technician III (UXO Supervisor)	20	HR	0.00	112.46	0.00	0.00	$2,249.15	False
33041101	Airfare	1	LS	0.00	0.00	0.00	750.00	$750.00	True
33220213	Surveying - 3-man Crew	2	DAY	0.00	3,940.00	33.41	0.00	$7,946.83	False
33240101	Other Direct Costs	1	LS	357.06	0.00	0.00	0.00	$357.06	True

Total Element Cost: $11,623.04

Element: Vegetation Removal

Technology: MEC Removal Action

Phase	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Cost	Extended Cost	Cost Override
17010401	Chipping brush, light brush	3	ACR	0.00	3,018.52	712.36	0.00	$9,327.20	False
17010402	Chipping brush, medium brush	3	ACR	0.00	3,880.76	915.84	0.00	$11,991.50	False
17010403	Chipping brush, heavy brush	5	ACR	0.00	7,547.64	1,781.21	0.00	$46,644.28	False
33010202	Per Diem (per person)	10	DAY	0.00	0.00	0.00	160.00	$1,600.00	True
33040935	UXO Technician III (UXO Supervisor)	70	HR	0.00	112.46	0.00	0.00	$7,872.03	False

Total Element Cost: $77,435.00

Element: UXO Mapping

Phase	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Cost	Extended Cost	Cost Override
33010202	Per Diem (per person)	121	DAY	0.00	0.00	0.00	160.00	$19,360.00	True
33040213	White's All Metals, weekly rental	21	WK	0.00	0.00	0.00	359.64	$7,552.44	True
33040651	4 X 4 Truck- Rental/Lease	35	DAY	0.00	0.00	167.27	0.00	$5,854.58	False
33040934	UXO Technician II	600	HR	0.00	95.64	0.00	0.00	$57,383.10	False
33040935	UXO Technician III (UXO Supervisor)	100	HR	0.00	112.46	0.00	0.00	$11,245.75	False
33041101	Airfare	7	LS	0.00	0.00	0.00	750.00	$5,250.00	True
33240101	Other Direct Costs	1	LS	4,365.70	0.00	0.00	0.00	$4,365.70	True

Total Element Cost: $111,011.58

Technology: MEC Removal Action

Element: UXO Removal

Phase	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Cost	Extended Cost	Cost Override
33010202	Per Diem (per person)	23	DAY	0.00	0.00	0.00	160.00	$3,680.00	True
33040213	White's All Metals, weekly rental	4	WK	0.00	0.00	0.00	359.64	$1,438.56	True
33040646	Backhoe - Rental/Lease	4	DAY	0.00	0.00	597.66	0.00	$2,390.65	False
33040651	4 X 4 Truck- Rental/Lease	7	DAY	0.00	0.00	167.27	0.00	$1,170.92	False
33040934	UXO Technician II	120	HR	0.00	95.64	0.00	0.00	$11,476.62	False
33040935	UXO Technician III (UXO Supervisor)	20	HR	0.00	112.46	0.00	0.00	$2,249.15	False
33041001	16oz Standard TNT Booster	4	EA	0.92	0.00	0.00	0.00	$3.68	False
33041002	50 gr/ft Det -Cord (1000 ft roll)	1	EA	1,144.46	0.00	0.00	0.00	$1,144.46	False
33041004	12 ft Lead Primadet Non- Electric Detonators	2	EA	13.73	0.00	0.00	0.00	$27.47	False
33240101	Other Direct Costs	1	LS	965.62	0.00	0.00	0.00	$965.62	True

Total Element Cost: $24,547.13

Element: Site Management

Phase	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Cost	Extended Cost	Cost Override
33010202	Per Diem (per person)	144	DAY	0.00	0.00	0.00	160.00	$23,040.00	True
33040651	4 X 4 Truck- Rental/Lease	147	DAY	0.00	0.00	167.27	0.00	$24,589.25	False
33040921	Senior UXO Supervisor (SUXOS)	210	HR	0.00	138.28	0.00	0.00	$29,038.63	False
33040923	UXO Project Manager	210	HR	0.00	203.43	0.00	0.00	$42,719.48	False

Technology: MEC Removal Action

33040930	UXO QC Specialist	210	HR	0.00	126.94	0.00	0.00	$26,657.74	False
33040931	UXO Safety Officer	210	HR	0.00	128.91	0.00	0.00	$27,070.06	False
33041101	Airfare	4	LS	0.00	0.00	0.00	750.00	$3,000.00	True

Total Element Cost: $176,115.16

Element: Stakeholder Involvement

Phase	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Cost	Extended Cost	Cost Override
33040923	UXO Project Manager	16	HR	0.00	203.43	0.00	0.00	$3,254.82	False
33040935	UXO Technician III (UXO Supervisor)	16	HR	0.00	112.46	0.00	0.00	$1,799.32	False
33041303	Site Specific Workplan (High Complexity)	1	EA	200.58	57,523.92	0.00	0.00	$57,724.49	False
33041306	Explosive Safety Submission (High Complexity)	1	EA	401.15	30,045.69	0.00	0.00	$30,446.85	False
33041315	UXO Removal Report (High Complexity)	1	EA	601.73	76,518.01	0.00	0.00	$77,119.74	False

Total Element Cost: $170,345.22

Total 1st Year Tech Cost: $594,704.90

Technology: Construction Support

Element:

		Unit of	Material	Labor Unit	Equipment	Sub Bid		Cost

Technology: Construction Support

Phase	Description	Quantity	Measure	Unit Cost	Cost	Unit Cost	Cost	Extended Cost	Override
33010108	Sedan, Automobile, Rental	10	DAY	0.00	0.00	0.00	94.57	$945.66	False
33010202	Per Diem (per person)	64	DAY	0.00	0.00	0.00	116.00	$7,424.00	True
33040213	White's All Metals, weekly rental	32	WK	0.00	0.00	0.00	359.64	$11,508.48	True
33040651	4 X 4 Truck- Rental/Lease	10	DAY	0.00	0.00	167.27	0.00	$1,672.74	False
33040921	Senior UXO Supervisor (SUXOS)	100	HR	0.00	113.39	0.00	0.00	$11,338.89	False
33040923	UXO Project Manager	100	HR	0.00	166.81	0.00	0.00	$16,680.94	False
33040930	UXO QC Specialist	100	HR	0.00	104.09	0.00	0.00	$10,409.21	False
33040931	UXO Safety Officer	100	HR	0.00	105.70	0.00	0.00	$10,570.21	False
33040934	UXO Technician II	100	HR	0.00	78.42	0.00	0.00	$7,842.36	False
33041001	16oz Standard TNT Booster	8	EA	0.92	0.00	0.00	0.00	$7.36	False
33041002	50 gr/ft Det -Cord (1000 ft roll)	2	EA	1,144.46	0.00	0.00	0.00	$2,288.93	False
33041004	12 ft Lead Primadet Non- Electric Detonators	4	EA	13.73	0.00	0.00	0.00	$54.93	False
33041101	Airfare	10	LS	0.00	0.00	0.00	0.00	$0.00	False
33041301	Site Specific Workplan (Low Complexity)	2	EA	200.58	26,873.59	0.00	0.00	$54,148.33	False
33041304	Explosive Safety Submission (Low Complexity)	2	EA	401.15	8,628.45	0.00	0.00	$18,059.21	False
33041313	UXO Removal Report (Low Complexity)	2	EA	200.58	27,647.36	0.00	0.00	$55,695.87	False

Total Element Cost:	$208,647.13
Total 1st Year Tech Cost:	$208,647.13

Total Phase Element Cost	**$869,525.39**

Alternative 4: Partial Surface MEC Removal with Risk Management Phase Cost Over Time Report (with Markups)

System:

RACER Version: RACER™ Version 11.0.98.0
Database Location: C:\Users\e.rgshare\Documents\RACER\Racer.mdb

Folder:

Folder Name: West_Point

Project:

ID: 8255-5AC
Name: West Point MMRP Feasibility Studies
Category: None

Location
State / Country: NEW YORK
City: WEST POINT MILITARY RESERV

Location Modifier	Default	User	Reason for changes
	1.480	1.480	

Options
Database: Modified System Costs
Cost Database Date: 2012
Report Option: Calendar

Description Includes the development of FSs for seven MRSs located at West Point Military Reserve in New York.

Site:

ID: WSTPT-015-R-02
Name: Siege Battery - Constitution Island
Type: MMRP

Media/Waste Type

Primary: Ordnance (not residual)
Secondary: Soil

Contaminant

Primary: Ordnance (not residual)
Secondary: Ordnance (residual)

Phase Names

Pre-Study ☐
Study ☐
Design ☐
Removal/Interim Action ☐
Remedial Action ☑
Operations & Maintenance ☐
Long Term Monitoring ☑
Site Closeout ☐

Documentation

Description: 1. Alternative 1: No Action
2. Alternative 2: Risk Management
3. Alternative 3: MEC Removal to Qualify for UU/UE
4. Alternative 4: Partial Surface MEC Removal with Risk Management
5. Alternative 5: Partial Surface/Subsurface MEC Removal with Risk Management
6. Alternative 6: Complete Surface MEC Removal with Risk Management

Support Team: Patrick Reilley: Project Manager
Ali Sadrieh: Program Manager

References: The Remedial Investigation Report (Weston, 2015) and USAG West Point were used to develop the costs included in this report.

Estimator Information

Estimator Name: Jeffrey S. Miller
Estimator Title: Environmental Scientist
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Alexandria, VA 22312
Telephone Number: 571.527.1224
Email Address: jmiller@plexsci.com

Estimate Prepared Date: 02/16/2017

Estimator Signature: _____ **Date:** _____

Reviewer Information

Reviewer Name: Jarett McDonald
Reviewer Title: Project Scientist
Agency/Org./Office: Plexus Scientific Corporation
Business Address: 5510 Cherokee Avenue - Suite 350
Alexandria, VA 22312
Telephone Number: 302.547.3876
Email Address: jmcdonald@plexsci.com

Date Reviewed: 02/16/2017

Reviewer Signature: _____ **Date:** _____

Technology Name	Technology	2017	2018	2019	2020	2021	2022
Construction Support	1	$0	$0	$0	$0	$0	$0
Five-Year Review	1	$0	$0	$0	$0	$0	$6,828
Land Use Controls	1	$57,417	$1,723	$1,723	$1,723	$1,723	$1,723
MEC Removal Action	1	$594,705	$0	$0	$0	$0	$0
Permitting	1	$0	$0	$0	$0	$0	$0
Total Phase Cost		$652,122	$1,723	$1,723	$1,723	$1,723	$8,551

Technology Name	Technology	2023	2024	2025	2026	2027	2028
Construction Support	1	$0	$0	$0	$0	$0	$0
Five-Year Review	1	$0	$0	$0	$0	$6,828	$0
Land Use Controls	1	$1,723	$1,723	$1,723	$1,723	$1,723	$1,723
MEC Removal Action	1	$0	$0	$0	$0	$0	$0
Permitting	1	$0	$0	$0	$0	$0	$0
Total Phase Cost		$1,723	$1,723	$1,723	$1,723	$8,551	$1,723

Technology Name	Technology	2029	2030	2031	2032	2033	2034
Construction Support	1	$0	$0	$104,324	$0	$0	$0
Five-Year Review	1	$0	$0	$0	$6,828	$0	$0
Land Use Controls	1	$1,723	$1,723	$1,723	$1,723	$1,723	$1,723
MEC Removal Action	1	$0	$0	$0	$0	$0	$0
Permitting	1	$0	$0	$103	$0	$0	$0
Total Phase Cost		$1,723	$1,723	$106,150	$8,551	$1,723	$1,723

Technology Name	Technology	2035	2036	2037	2038	2039	2040
Construction Support	1	$0	$0	$0	$0	$0	$0
Five-Year Review	1	$0	$0	$6,828	$0	$0	$0
Land Use Controls	1	$1,723	$1,723	$1,723	$1,723	$1,723	$1,723
MEC Removal Action	1	$0	$0	$0	$0	$0	$0
Permitting	1	$0	$0	$0	$0	$0	$0
Total Phase Cost		$1,723	$1,723	$8,551	$1,723	$1,723	$1,723

Technology Name	Technology	2041	2042	2043	2044	2045	2046
Construction Support	1	$0	$0	$0	$0	$0	$104,324
Five-Year Review	1	$0	$6,828	$0	$0	$0	$0
Land Use Controls	1	$1,723	$1,723	$1,723	$1,723	$1,723	$1,723
MEC Removal Action	1	$0	$0	$0	$0	$0	$0
Permitting	1	$0	$0	$0	$0	$0	$103
Total Phase Cost		$1,723	$8,551	$1,723	$1,723	$1,723	$106,150

Technology Name	Technology	Total					
Construction Support	1	$208,647					
Five-Year Review	1	$34,139					
Land Use Controls	1	$107,376					
MEC Removal Action	1	$594,705					
Permitting	1	$205					
Total Phase Cost		$945,072	$0	$0	$0	$0	$0

Alternative 5: Partial Surface/Subsurface MEC Removal with Risk Management
Phase Technology Cost Detail Report (with Markups)

System:

RACER Version: RACER™ Version 11.0.98.0
Database Location: C:\Users\e.rgshare\Documents\RACER\Racer.mdb

Folder:

Folder Name: West_Point

Project:

ID: 8255-5AC
Name: West Point MMRP Feasibility Studies
Category: None

Location
State / Country: NEW YORK
City: WEST POINT MILITARY RESERV

Location Modifier	Default	User	Reason for changes
	1.480	1.480	

Options
Database: Modified System Costs
Cost Database Date: 2012
Report Option: Calendar

Description Includes the development of FSs for seven MRSs located at West Point

Military Reserve in New York.

Site:

ID: WSTPT-015-R-02
Name: Siege Battery - Constitution Island
Type: MMRP

Media/Waste Type

Primary: Ordnance (not residual)
Secondary: Soil

Contaminant

Primary: Ordnance (not residual)
Secondary: Ordnance (residual)

Phase Names

Pre-Study ☐
Study ☐
Design ☐
Removal/Interim Action ☐
Remedial Action ☑
Operations & Maintenance ☐
Long Term Monitoring ☑
Site Closeout ☐

Documentation

Description: 1. Alternative 1: No Action
2. Alternative 2: Risk Management
3. Alternative 3: MEC Removal to Qualify for UU/UE
4. Alternative 4: Partial Surface MEC Removal with Risk Management
5. Alternative 5: Partial Surface/Subsurface MEC Removal with Risk Management
6. Alternative 6: Complete Surface MEC Removal with Risk Management

Support Team: Patrick Reilley: Project Manager
Ali Sadrieh: Program Manager

References: The Remedial Investigation Report (Weston, 2015) and USAG West Point were used to develop the costs included in this report.

Estimator Information

Estimator Name: Jeffrey S. Miller
Estimator Title: Environmental Scientist
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Business Address: 5510 Cherokee Avenue - Suite 350
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Email Address: jmiller@plexsci.com

Estimate Prepared Date: 02/16/2017

Estimator Signature: _____ **Date:** _____

Reviewer Information

Reviewer Name: Jarett McDonald
Reviewer Title: Project Scientist
Agency/Org./Office: Plexus Scientific Corporation
Business Address: 5510 Cherokee Avenue - Suite 350
Alexandria, VA 22312
Telephone Number: 302.547.3876
Email Address: jmcdonald@plexsci.com

Date Reviewed: 02/16/2017

Reviewer Signature: _____ **Date:** _____

Phase Documentation:

Phase Type: Remedial Action
Phase Name: Alt.5: Partial Surface/Sub MEC Removal with RM
Description: Removal of surface/subsurface MEC from the 10-acre area followed by LUC (administrative mechanisms/educational controls) implementation across the entire MRS (52 acres).
Approach: Ex Situ
Start Date: August, 2017
Labor Rate Group: System Labor Rate
Analysis Rate Group: System Analysis Rate
Phase Markup Template: System Defaults

Technology Markups	Markup	% Prime	% Sub.
MEC Removal Action	True	20	80
Land Use Controls	False	0	0
Five-Year Review	False	0	0
Permitting	False	0	0
Construction Support	True	20	80
Clear and Grub	True	20	80

Total Marked-up Cost: $1,134,265.12

Technologies:

Technology: MEC Removal Action

Element: Site Visit

Phase	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Cost	Extended Cost	Cost Override
33010108	Sedan, Automobile, Rental	3	DAY	0.00	0.00	0.00	94.57	$283.70	False
33010202	Per Diem (per person)	9	DAY	0.00	0.00	0.00	160.00	$1,440.00	True
33040921	Senior UXO Supervisor (SUXOS)	40	HR	0.00	138.28	0.00	0.00	$5,531.17	False
33040923	UXO Project Manager	40	HR	0.00	203.43	0.00	0.00	$8,137.04	False
33040925	UXO Staff Engineer	40	HR	0.00	129.72	0.00	0.00	$5,188.66	False
33041101	Airfare	3	LS	0.00	0.00	0.00	750.00	$2,250.00	True
33240101	Other Direct Costs	1	LS	797.20	0.00	0.00	0.00	$797.20	True

Total Element Cost: $23,627.77

Element: Surveying

Phase	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Cost	Extended Cost	Cost Override
33010202	Per Diem (per person)	2	DAY	0.00	0.00	0.00	160.00	$320.00	True
33040671	Portable GPS Set with Mapping, 5 cm Accuracy	1	MO	5,639.73	0.00	0.00	0.00	$5,639.73	False
33040935	UXO Technician III (UXO Supervisor)	20	HR	0.00	112.46	0.00	0.00	$2,249.15	False
33041101	Airfare	1	LS	0.00	0.00	0.00	750.00	$750.00	True
33220213	Surveying - 3-man Crew	2	DAY	0.00	3,940.00	33.41	0.00	$7,946.83	False
33240101	Other Direct Costs	1	LS	526.25	0.00	0.00	0.00	$526.25	True

Total Element Cost: $17,431.96

Element: UXO Mapping

Phase	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Cost	Extended Cost	Cost Override
33010202	Per Diem (per person)	195	DAY	0.00	0.00	0.00	160.00	$31,200.00	True
33021530	Differential GPS Unit Rental	2	MO	469.98	0.00	0.00	0.00	$939.95	False
33040213	White's All Metals, weekly rental	29	WK	0.00	0.00	0.00	359.64	$10,429.56	True
33040230	Geonics EM-61 Metal Locator, Hand Held (Weekly Rental)	1	WK	0.00	0.00	0.00	661.08	$661.08	False
33040651	4 X 4 Truck- Rental/Lease	59	DAY	0.00	0.00	167.27	0.00	$9,869.15	False
33040653	All Terrain Vehicle (ATV) - Rental/Lease	1	DAY	0.00	0.00	0.00	319.36	$319.36	False
33040934	UXO Technician II	900	HR	0.00	95.64	0.00	0.00	$86,074.65	False
33040935	UXO Technician III (UXO Supervisor)	180	HR	0.00	112.46	0.00	0.00	$20,242.36	False
33040936	Geophysicist (UXO)	60	HR	0.00	183.39	0.00	0.00	$11,003.42	False
33041101	Airfare	10	LS	0.00	0.00	0.00	750.00	$7,500.00	True
33240101	Other Direct Costs	1	LS	7,377.52	0.00	0.00	0.00	$7,377.52	True

Total Element Cost: $185,617.06

Element: UXO Removal

Phase	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Cost	Extended Cost	Cost Override
33010202	Per Diem (per person)	23	DAY	0.00	0.00	0.00	160.00	$3,680.00	True
33040149	Nonsparking UXO Shovels	7	EA	122.59	0.00	0.00	0.00	$858.11	False

Technology: MEC Removal Action

33040213	White's All Metals, weekly rental	4	WK	0.00	0.00	0.00	359.64	$1,438.56	True
33040646	Backhoe - Rental/Lease	4	DAY	0.00	0.00	597.66	0.00	$2,390.65	False
33040651	4 X 4 Truck- Rental/Lease	7	DAY	0.00	0.00	167.27	0.00	$1,170.92	False
33040934	UXO Technician II	120	HR	0.00	95.64	0.00	0.00	$11,476.62	False
33040935	UXO Technician III (UXO Supervisor)	20	HR	0.00	112.46	0.00	0.00	$2,249.15	False
33041001	16oz Standard TNT Booster	4	EA	0.92	0.00	0.00	0.00	$3.68	False
33041002	50 gr/ft Det -Cord (1000 ft roll)	1	EA	1,144.46	0.00	0.00	0.00	$1,144.46	False
33041004	12 ft Lead Primadet Non- Electric Detonators	2	EA	13.73	0.00	0.00	0.00	$27.47	False
33240101	Other Direct Costs	1	LS	965.62	0.00	0.00	0.00	$965.62	True

Total Element Cost: $25,405.24

Element: Site Management

Phase	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Cost	Extended Cost	Cost Override
33010202	Per Diem (per person)	148	DAY	0.00	0.00	0.00	160.00	$23,680.00	True
33040651	4 X 4 Truck- Rental/Lease	154	DAY	0.00	0.00	167.27	0.00	$25,760.16	False
33040921	Senior UXO Supervisor (SUXOS)	220	HR	0.00	138.28	0.00	0.00	$30,421.42	False
33040923	UXO Project Manager	220	HR	0.00	203.43	0.00	0.00	$44,753.74	False
33040930	UXO QC Specialist	220	HR	0.00	126.94	0.00	0.00	$27,927.15	False
33040931	UXO Safety Officer	220	HR	0.00	128.91	0.00	0.00	$28,359.11	False
33041101	Airfare	4	LS	0.00	0.00	0.00	750.00	$3,000.00	True

						Total Element Cost:		$183,901.59	

Element: Stakeholder Involvement

Phase	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Cost	Extended Cost	Cost Override
33040923	UXO Project Manager	16	HR	0.00	203.43	0.00	0.00	$3,254.82	False
33040935	UXO Technician III (UXO Supervisor)	16	HR	0.00	112.46	0.00	0.00	$1,799.32	False
33041303	Site Specific Workplan (High Complexity)	1	EA	200.58	57,523.92	0.00	0.00	$57,724.49	False
33041306	Explosive Safety Submission (High Complexity)	1	EA	401.15	30,045.69	0.00	0.00	$30,446.85	False
33041315	UXO Removal Report (High Complexity)	1	EA	601.73	76,518.01	0.00	0.00	$77,119.74	False

						Total Element Cost:		$170,345.22	
						Total 1st Year Tech Cost:		$606,328.85	

Technology: Land Use Controls

Element: Planning Docs

Phase	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Cost	Extended Cost	Cost Override
33220102	Project Manager	22	HR	0.00	100.83	0.00	0.00	$2,218.20	False
33220105	Project Engineer	30	HR	0.00	84.21	0.00	0.00	$2,526.18	False
33220106	Staff Engineer	45	HR	0.00	112.82	0.00	0.00	$5,076.86	False
33220110	QA/QC Officer	11	HR	0.00	93.15	0.00	0.00	$1,024.68	False

Technology: Land Use Controls

33220114	Word Processing/Clerical	60	HR	0.00	50.28	0.00	0.00	$3,016.97	False
33220115	Draftsman/CADD	30	HR	0.00	53.92	0.00	0.00	$1,617.62	False
33220503	Attorney, Partner, Real Estate	22	HR	0.00	358.18	0.00	0.00	$7,879.92	False
33240101	Other Direct Costs	1	LS	584.01	0.00	0.00	0.00	$584.01	True

Total Element Cost: $23,944.43

Element: Planning Meetings

Phase	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Cost	Extended Cost	Cost Override
33010104	Vehicle mileage charge, car or van	10	MI	0.00	0.00	0.00	0.51	$5.10	True
33010202	Per Diem (per person)	1	DAY	0.00	0.00	0.00	160.00	$160.00	True
33220102	Project Manager	21	HR	0.00	100.83	0.00	0.00	$2,117.37	False
33220114	Word Processing/Clerical	16	HR	0.00	50.28	0.00	0.00	$804.53	False
33220115	Draftsman/CADD	8	HR	0.00	53.92	0.00	0.00	$431.36	False
33240101	Other Direct Costs	1	LS	83.83	0.00	0.00	0.00	$83.83	True

Total Element Cost: $3,602.19

Element: Implementation

Phase	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Cost	Extended Cost	Cost Override
33022037	Overnight Delivery, 8 oz Letter	8	EA	0.00	0.00	0.00	26.85	$214.78	False
33040671	Portable GPS Set with Mapping,	1	MO	3,537.20	0.00	0.00	0.00	$3,537.20	False

Technology: Land Use Controls

	5 cm Accuracy								
33220102	Project Manager	30	HR	0.00	100.83	0.00	0.00	$3,024.81	False
33220105	Project Engineer	45	HR	0.00	84.21	0.00	0.00	$3,789.27	False
33220106	Staff Engineer	60	HR	0.00	112.82	0.00	0.00	$6,769.15	False
33220110	QA/QC Officer	13	HR	0.00	93.15	0.00	0.00	$1,210.99	False
33220114	Word Processing/Clerical	30	HR	0.00	50.28	0.00	0.00	$1,508.49	False
33220115	Draftsman/CADD	90	HR	0.00	53.92	0.00	0.00	$4,852.85	False
33220212	Surveying - 2-man Crew	3	DAY	0.00	1,421.64	20.96	0.00	$4,327.80	False
33240101	Other Direct Costs	1	LS	635.51	0.00	0.00	0.00	$635.51	True

Total Element Cost: $29,870.84

Element: Monitoring & Enforcement

Phase	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Cost	Extended Cost	Cost Override
33010104	Vehicle mileage charge, car or van	15	MI	0.00	0.00	0.00	0.51	$7.65	True
33010202	Per Diem (per person)	2	DAY	0.00	0.00	0.00	160.00	$320.00	True
33220102	Project Manager	13	HR	0.00	100.83	0.00	0.00	$1,310.75	False
33220114	Word Processing/Clerical	1	HR	0.00	50.28	0.00	0.00	$50.28	False
33240101	Other Direct Costs	1	LS	34.03	0.00	0.00	0.00	$34.03	True

Total Element Cost: $1,722.71

Total 1st Year Tech Cost: $59,140.18

Technology: Five-Year Review

Element: Document Review

Phase	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Cost	Extended Cost	Cost Override
33220105	Project Engineer	2	HR	0.00	102.69	0.00	0.00	$205.38	False
33220108	Project Scientist	1	HR	0.00	113.60	0.00	0.00	$113.60	False
33220109	Staff Scientist	2	HR	0.00	65.76	0.00	0.00	$131.51	False

Total Element Cost: $450.49

Element: Site Inspection

Phase	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Cost	Extended Cost	Cost Override
33220102	Project Manager	2	HR	0.00	122.96	0.00	0.00	$245.92	False
33220105	Project Engineer	2	HR	0.00	102.69	0.00	0.00	$205.38	False
33220108	Project Scientist	2	HR	0.00	113.60	0.00	0.00	$227.20	False
33220109	Staff Scientist	2	HR	0.00	65.76	0.00	0.00	$131.51	False

Total Element Cost: $810.02

Element: Report

Phase	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Cost	Extended Cost	Cost Override
33220102	Project Manager	6	HR	0.00	122.96	0.00	0.00	$737.76	False
33220105	Project Engineer	16	HR	0.00	102.69	0.00	0.00	$1,643.04	False

Technology: Five-Year Review

33220108	Project Scientist	13	HR	0.00	113.60	0.00	0.00	$1,476.81	False
33220109	Staff Scientist	26	HR	0.00	65.76	0.00	0.00	$1,709.68	False

Total Element Cost:	$5,567.29
Total 1st Year Tech Cost:	$6,827.80

Technology: Permitting

Element:

Phase	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Cost	Extended Cost	Cost Override
33220105	Project Engineer	2	HR	0.00	102.69	0.00	0.00	$205.38	False

Total Element Cost:	$205.38
Total 1st Year Tech Cost:	$205.38

Technology: Clear and Grub

Element:

Phase	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Cost	Extended Cost	Cost Override
17010210	Site clearing trees, with 335 H.P. dozer, to 6" diameter	1,250	EA	0.00	6.74	8.55	0.00	$19,111.61	False
17010314	Grub stumps, with 335 H.P. dozer, to 6" diameter	1,250	EA	0.00	4.72	5.98	0.00	$13,377.87	False

Technology: Clear and Grub

17010403	Chipping brush, heavy brush	10	ACR	0.00	7,547.64	1,781.21	0.00	$93,288.55	False
17010501	Grub and stack, 140 H.P. dozer	2,017	CY	0.00	7.55	3.99	0.00	$23,268.82	False
17030226	988, 7.0 CY, Wheel Loader	16	HR	0.00	168.17	238.68	0.00	$6,509.59	False
17030296	50 Ton, 773, Off-highway Truck	33	HR	0.00	156.52	322.07	0.00	$15,793.23	False
33010118	Mobilize/Demobilize Dozer, Loader, Backhoe or Excavator, 70 H.P. to 150 H.P., up to 50 miles	4	LS	0.00	313.03	226.09	0.00	$2,156.49	False
33029501	Shipping	2	LS	36.40	0.00	0.00	0.00	$72.79	False
33040213	White's All Metals, weekly rental	1	WK	0.00	0.00	0.00	164.19	$164.19	False
33040934	UXO Technician II	40	HR	0.00	95.64	0.00	0.00	$3,825.54	False

Total Element Cost: $177,568.68

Total 1st Year Tech Cost: $177,568.68

Technology: Construction Support

Element:

Phase	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Cost	Extended Cost	Cost Override
33010108	Sedan, Automobile, Rental	10	DAY	0.00	0.00	0.00	94.57	$945.66	False
33010202	Per Diem (per person)	64	DAY	0.00	0.00	0.00	116.00	$7,424.00	True
33040213	White's All Metals, weekly rental	32	WK	0.00	0.00	0.00	359.64	$11,508.48	True
33040651	4 X 4 Truck- Rental/Lease	10	DAY	0.00	0.00	167.27	0.00	$1,672.74	False
33040921	Senior UXO Supervisor (SUXOS)	100	HR	0.00	113.39	0.00	0.00	$11,338.89	False

Technology: Construction Support

33040923	UXO Project Manager	100	HR	0.00	166.81	0.00	0.00	$16,680.94	False
33040930	UXO QC Specialist	100	HR	0.00	104.09	0.00	0.00	$10,409.21	False
33040931	UXO Safety Officer	100	HR	0.00	105.70	0.00	0.00	$10,570.21	False
33040934	UXO Technician II	100	HR	0.00	78.42	0.00	0.00	$7,842.36	False
33041001	16oz Standard TNT Booster	8	EA	0.92	0.00	0.00	0.00	$7.36	False
33041002	50 gr/ft Det -Cord (1000 ft roll)	2	EA	1,144.46	0.00	0.00	0.00	$2,288.93	False
33041004	12 ft Lead Primadet Non- Electric Detonators	4	EA	13.73	0.00	0.00	0.00	$54.93	False
33041101	Airfare	10	LS	0.00	0.00	0.00	0.00	$0.00	False
33041301	Site Specific Workplan (Low Complexity)	2	EA	200.58	26,873.59	0.00	0.00	$54,148.33	False
33041304	Explosive Safety Submission (Low Complexity)	2	EA	401.15	8,628.45	0.00	0.00	$18,059.21	False
33041313	UXO Removal Report (Low Complexity)	2	EA	200.58	27,647.36	0.00	0.00	$55,695.87	False

Total Element Cost:	$208,647.13
Total 1st Year Tech Cost:	$208,647.13
Total Phase Element Cost	**$1,058,718.01**

Alternative 5: Partial Surface/Subsurface MEC Removal with Risk Management
Phase Cost Over Time Report (with Markups)

System:

RACER Version: RACER™ Version 11.0.98.0
Database Location: C:\Users\e.rgshare\Documents\RACER\Racer.mdb

Folder:

Folder Name: West_Point

Project:

ID: 8255-5AC
Name: West Point MMRP Feasibility Studies
Category: None

Location
State / Country: NEW YORK
City: WEST POINT MILITARY RESERV

Location Modifier	Default	User	Reason for changes
	1.480	1.480	

Options
Database: Modified System Costs
Cost Database Date: 2012
Report Option: Calendar

Description Includes the development of FSs for seven MRSs located at West Point Military Reserve in New York.

Site:

ID: WSTPT-015-R-02
Name: Siege Battery - Constitution Island
Type: MMRP

Media/Waste Type

Primary: Ordnance (not residual)
Secondary: Soil

Contaminant

Primary: Ordnance (not residual)
Secondary: Ordnance (residual)

Phase Names

Pre-Study ☐
Study ☐
Design ☐
Removal/Interim Action ☐
Remedial Action ☑
Operations & Maintenance ☐
Long Term Monitoring ☑
Site Closeout ☐

Documentation

Description: 1. Alternative 1: No Action
2. Alternative 2: Risk Management
3. Alternative 3: MEC Removal to Qualify for UU/UE
4. Alternative 4: Partial Surface MEC Removal with Risk Management
5. Alternative 5: Partial Surface/Subsurface MEC Removal with Risk Management
6. Alternative 6: Complete Surface MEC Removal with Risk Management

Support Team: Patrick Reilley: Project Manager
Ali Sadrieh: Program Manager

References: The Remedial Investigation Report (Weston, 2015) and USAG West Point were used to develop the costs included in this report.

Estimator Information

Estimator Name: Jeffrey S. Miller
Estimator Title: Environmental Scientist
Agency/Org./Office: Plexus Scientific Corporation
Business Address: 5510 Cherokee Avenue - Suite 350
Alexandria, VA 22312
Telephone Number: 571.527.1224
Email Address: jmiller@plexsci.com

Estimate Prepared Date: 02/16/2017

Estimator Signature: _____ **Date:** _____

Reviewer Information

Reviewer Name: Jarett McDonald
Reviewer Title: Project Scientist
Agency/Org./Office: Plexus Scientific Corporation
Business Address: 5510 Cherokee Avenue - Suite 350
Alexandria, VA 22312
Telephone Number: 302.547.3876
Email Address: jmcdonald@plexsci.com

Date Reviewed: 02/16/2017

Reviewer Signature: _____ **Date:** _____

Technology Name	Technology	2017	2018	2019	2020	2021	2022
Clear and Grub	1	$177,569	$0	$0	$0	$0	$0
Construction Support	1	$0	$0	$0	$0	$0	$0
Five-Year Review	1	$0	$0	$0	$0	$0	$6,828
Land Use Controls	1	$57,417	$1,723	$1,723	$1,723	$1,723	$1,723
MEC Removal Action	1	$606,329	$0	$0	$0	$0	$0
Permitting	1	$0	$0	$0	$0	$0	$0
Total Phase Cost		$841,315	$1,723	$1,723	$1,723	$1,723	$8,551

Technology Name	Technology	2023	2024	2025	2026	2027	2028
Clear and Grub	1	$0	$0	$0	$0	$0	$0
Construction Support	1	$0	$0	$0	$0	$0	$0
Five-Year Review	1	$0	$0	$0	$0	$6,828	$0
Land Use Controls	1	$1,723	$1,723	$1,723	$1,723	$1,723	$1,723
MEC Removal Action	1	$0	$0	$0	$0	$0	$0
Permitting	1	$0	$0	$0	$0	$0	$0
Total Phase Cost		$1,723	$1,723	$1,723	$1,723	$8,551	$1,723

Technology Name	Technology	2029	2030	2031	2032	2033	2034
Clear and Grub	1	$0	$0	$0	$0	$0	$0
Construction Support	1	$0	$0	$104,324	$0	$0	$0
Five-Year Review	1	$0	$0	$0	$6,828	$0	$0
Land Use Controls	1	$1,723	$1,723	$1,723	$1,723	$1,723	$1,723
MEC Removal Action	1	$0	$0	$0	$0	$0	$0
Permitting	1	$0	$0	$103	$0	$0	$0
Total Phase Cost		$1,723	$1,723	$106,150	$8,551	$1,723	$1,723

Technology Name	Technology	2035	2036	2037	2038	2039	2040
Clear and Grub	1	$0	$0	$0	$0	$0	$0
Construction Support	1	$0	$0	$0	$0	$0	$0
Five-Year Review	1	$0	$0	$6,828	$0	$0	$0
Land Use Controls	1	$1,723	$1,723	$1,723	$1,723	$1,723	$1,723
MEC Removal Action	1	$0	$0	$0	$0	$0	$0
Permitting	1	$0	$0	$0	$0	$0	$0
Total Phase Cost		$1,723	$1,723	$8,551	$1,723	$1,723	$1,723

Technology Name	Technology	2041	2042	2043	2044	2045	2046
Clear and Grub	1	$0	$0	$0	$0	$0	$0
Construction Support	1	$0	$0	$0	$0	$0	$104,324
Five-Year Review	1	$0	$6,828	$0	$0	$0	$0
Land Use Controls	1	$1,723	$1,723	$1,723	$1,723	$1,723	$1,723
MEC Removal Action	1	$0	$0	$0	$0	$0	$0
Permitting	1	$0	$0	$0	$0	$0	$103
Total Phase Cost		$1,723	$8,551	$1,723	$1,723	$1,723	$106,150

Technology Name	Technology	Total					
Clear and Grub	1	$177,569					
Construction Support	1	$208,647					
Five-Year Review	1	$34,139					
Land Use Controls	1	$107,376					
MEC Removal Action	1	$606,329					
Permitting	1	$205					
Total Phase Cost		$1,134,265	$0	$0	$0	$0	$0

Alternative 6: Surface MEC Removal with Risk Management
Phase Technology Cost Detail Report (with Markups)

System:

RACER Version: RACER™ Version 11.0.98.0
Database Location: C:\Users\e.rgshare\Documents\RACER\Racer.mdb

Folder:

Folder Name: West_Point

Project:

ID: 8255-5AC
Name: West Point MMRP Feasibility Studies
Category: None

Location
State / Country: NEW YORK
City: WEST POINT MILITARY RESERV

Location Modifier	Default	User	Reason for changes
	1.480	1.480	

Options
Database: Modified System Costs
Cost Database Date: 2012
Report Option: Calendar

Description Includes the development of FSs for seven MRSs located at West Point

Military Reserve in New York.

Site:

ID: WSTPT-015-R-02
Name: Siege Battery - Constitution Island
Type: MMRP

Media/Waste Type

Primary: Ordnance (not residual)
Secondary: Soil

Contaminant

Primary: Ordnance (not residual)
Secondary: Ordnance (residual)

Phase Names

Pre-Study ☐
Study ☐
Design ☐
Removal/Interim Action ☐
Remedial Action ☑
Operations & Maintenance ☐
Long Term Monitoring ☑
Site Closeout ☐

Documentation

Description: 1. Alternative 1: No Action
2. Alternative 2: Risk Management
3. Alternative 3: MEC Removal to Qualify for UU/UE
4. Alternative 4: Partial Surface MEC Removal with Risk Management
5. Alternative 5: Partial Surface/Subsurface MEC Removal with Risk Management
6. Alternative 6: Complete Surface MEC Removal with Risk Management

Support Team: Patrick Reilley: Project Manager
Ali Sadrieh: Program Manager

References: The Remedial Investigation Report (Weston, 2015) and USAG West Point were used to develop the costs included in this report.

Estimator Information

Estimator Name: Jeffrey S. Miller
Estimator Title: Environmental Scientist
Agency/Org./Office: Plexus Scientific Corporation
Business Address: 5510 Cherokee Avenue - Suite 350
Alexandria, VA 22312
Telephone Number: 571.527.1224
Email Address: jmiller@plexsci.com

Estimate Prepared Date: 02/16/2017

Estimator Signature: _____ **Date:** _____

Reviewer Information

Reviewer Name: Jarett McDonald
Reviewer Title: Project Scientist
Agency/Org./Office: Plexus Scientific Corporation
Business Address: 5510 Cherokee Avenue - Suite 350
Alexandria, VA 22312
Telephone Number: 302.547.3876
Email Address: jmcdonald@plexsci.com

Date Reviewed: 02/16/2017

Reviewer Signature: _____ **Date:** _____

Phase Documentation:

Phase Type: Remedial Action
Phase Name: Alt.6: Complete Surface MEC Removal with RM
Description: Removal of surface MEC from all 52 acres of the MRS followed by LUC (administrative mechanisms and educational controls) implementation across the entire MRS (52 acres).
Approach: Ex Situ
Start Date: August, 2017
Labor Rate Group: System Labor Rate
Analysis Rate Group: System Analysis Rate
Phase Markup Template: System Defaults

Technology Markups	Markup	% Prime	% Sub.
Land Use Controls	False	0	0
Five-Year Review	False	0	0
Permitting	False	0	0
MEC Removal Action	True	20	80
Construction Support	True	20	80

Total Marked-up Cost: $2,308,670.64

Technologies:

Technology: Land Use Controls

Technology: Land Use Controls

Element: Planning Docs

Phase	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Cost	Extended Cost	Cost Override
33220102	Project Manager	22	HR	0.00	100.83	0.00	0.00	$2,218.20	False
33220105	Project Engineer	30	HR	0.00	84.21	0.00	0.00	$2,526.18	False
33220106	Staff Engineer	45	HR	0.00	112.82	0.00	0.00	$5,076.86	False
33220110	QA/QC Officer	11	HR	0.00	93.15	0.00	0.00	$1,024.68	False
33220114	Word Processing/Clerical	60	HR	0.00	50.28	0.00	0.00	$3,016.97	False
33220115	Draftsman/CADD	30	HR	0.00	53.92	0.00	0.00	$1,617.62	False
33220503	Attorney, Partner, Real Estate	22	HR	0.00	358.18	0.00	0.00	$7,879.92	False
33240101	Other Direct Costs	1	LS	584.01	0.00	0.00	0.00	$584.01	True

Total Element Cost: $23,944.43

Element: Planning Meetings

Phase	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Cost	Extended Cost	Cost Override
33010104	Vehicle mileage charge, car or van	10	MI	0.00	0.00	0.00	0.51	$5.10	True
33010202	Per Diem (per person)	1	DAY	0.00	0.00	0.00	160.00	$160.00	True
33220102	Project Manager	21	HR	0.00	100.83	0.00	0.00	$2,117.37	False
33220114	Word Processing/Clerical	16	HR	0.00	50.28	0.00	0.00	$804.53	False
33220115	Draftsman/CADD	8	HR	0.00	53.92	0.00	0.00	$431.36	False
33240101	Other Direct Costs	1	LS	83.83	0.00	0.00	0.00	$83.83	True

Total Element Cost: $3,602.19

Element: Implementation

Phase	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Cost	Extended Cost	Cost Override
33022037	Overnight Delivery, 8 oz Letter	8	EA	0.00	0.00	0.00	26.85	$214.78	False
33040671	Portable GPS Set with Mapping, 5 cm Accuracy	1	MO	3,537.20	0.00	0.00	0.00	$3,537.20	False
33220102	Project Manager	30	HR	0.00	100.83	0.00	0.00	$3,024.81	False
33220105	Project Engineer	45	HR	0.00	84.21	0.00	0.00	$3,789.27	False
33220106	Staff Engineer	60	HR	0.00	112.82	0.00	0.00	$6,769.15	False
33220110	QA/QC Officer	13	HR	0.00	93.15	0.00	0.00	$1,210.99	False
33220114	Word Processing/Clerical	30	HR	0.00	50.28	0.00	0.00	$1,508.49	False
33220115	Draftsman/CADD	90	HR	0.00	53.92	0.00	0.00	$4,852.85	False
33220212	Surveying - 2-man Crew	3	DAY	0.00	1,421.64	20.96	0.00	$4,327.80	False
33240101	Other Direct Costs	1	LS	635.51	0.00	0.00	0.00	$635.51	True

Total Element Cost: $29,870.84

Element: Monitoring & Enforcement

Phase	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Cost	Extended Cost	Cost Override
33010104	Vehicle mileage charge, car or van	15	MI	0.00	0.00	0.00	0.51	$7.65	True
33010202	Per Diem (per person)	2	DAY	0.00	0.00	0.00	160.00	$320.00	True
33220102	Project Manager	13	HR	0.00	100.83	0.00	0.00	$1,310.75	False
33220114	Word Processing/Clerical	1	HR	0.00	50.28	0.00	0.00	$50.28	False

Technology: Land Use Controls

33240101	Other Direct Costs	1	LS	34.03	0.00	0.00	0.00	$34.03	True

Total Element Cost: $1,722.71

Total 1st Year Tech Cost: $59,140.18

Technology: Five-Year Review

Element: Document Review

Phase	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Cost	Extended Cost	Cost Override
33220105	Project Engineer	2	HR	0.00	102.69	0.00	0.00	$205.38	False
33220108	Project Scientist	1	HR	0.00	113.60	0.00	0.00	$113.60	False
33220109	Staff Scientist	2	HR	0.00	65.76	0.00	0.00	$131.51	False

Total Element Cost: $450.49

Element: Site Inspection

Phase	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Cost	Extended Cost	Cost Override
33220102	Project Manager	2	HR	0.00	122.96	0.00	0.00	$245.92	False
33220105	Project Engineer	2	HR	0.00	102.69	0.00	0.00	$205.38	False
33220108	Project Scientist	2	HR	0.00	113.60	0.00	0.00	$227.20	False
33220109	Staff Scientist	2	HR	0.00	65.76	0.00	0.00	$131.51	False

					Total Element Cost:			$810.02	

Element: Report

Phase	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Cost	Extended Cost	Cost Override
33220102	Project Manager	6	HR	0.00	122.96	0.00	0.00	$737.76	False
33220105	Project Engineer	16	HR	0.00	102.69	0.00	0.00	$1,643.04	False
33220108	Project Scientist	13	HR	0.00	113.60	0.00	0.00	$1,476.81	False
33220109	Staff Scientist	26	HR	0.00	65.76	0.00	0.00	$1,709.68	False

					Total Element Cost:			$5,567.29	
					Total 1st Year Tech Cost:			$6,827.80	

Technology: Permitting

Element:

Phase	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Cost	Extended Cost	Cost Override
33220105	Project Engineer	2	HR	0.00	102.69	0.00	0.00	$205.38	False

					Total Element Cost:			$205.38	
					Total 1st Year Tech Cost:			$205.38	

Technology: MEC Removal Action

Element: Site Visit

Technology: MEC Removal Action

Phase	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Cost	Extended Cost	Cost Override
33010108	Sedan, Automobile, Rental	3	DAY	0.00	0.00	0.00	94.57	$283.70	False
33010202	Per Diem (per person)	9	DAY	0.00	0.00	0.00	160.00	$1,440.00	True
33040921	Senior UXO Supervisor (SUXOS)	40	HR	0.00	138.28	0.00	0.00	$5,531.17	False
33040923	UXO Project Manager	40	HR	0.00	203.43	0.00	0.00	$8,137.04	False
33040925	UXO Staff Engineer	40	HR	0.00	129.72	0.00	0.00	$5,188.66	False
33041101	Airfare	3	LS	0.00	0.00	0.00	750.00	$2,250.00	True
33240101	Other Direct Costs	1	LS	797.20	0.00	0.00	0.00	$797.20	True

Total Element Cost: $23,627.77

Element: Surveying

Phase	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Cost	Extended Cost	Cost Override
33010202	Per Diem (per person)	10	DAY	0.00	0.00	0.00	160.00	$1,600.00	True
33040935	UXO Technician III (UXO Supervisor)	70	HR	0.00	112.46	0.00	0.00	$7,872.03	False
33041101	Airfare	1	LS	0.00	0.00	0.00	750.00	$750.00	True
33220213	Surveying - 3-man Crew	7	DAY	0.00	3,940.00	33.41	0.00	$27,813.92	False
33240101	Other Direct Costs	1	LS	1,182.98	0.00	0.00	0.00	$1,182.98	True

Total Element Cost: $39,218.93

Element: Vegetation Removal

Technology: MEC Removal Action

Phase	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Cost	Extended Cost	Cost Override
17010401	Chipping brush, light brush	13	ACR	0.00	3,018.52	712.36	0.00	$48,501.42	False
17010402	Chipping brush, medium brush	13	ACR	0.00	3,880.76	915.84	0.00	$62,355.81	False
17010403	Chipping brush, heavy brush	26	ACR	0.00	7,547.64	1,781.21	0.00	$242,550.24	False
33010202	Per Diem (per person)	63	DAY	0.00	0.00	0.00	160.00	$10,080.00	True
33040935	UXO Technician III (UXO Supervisor)	360	HR	0.00	112.46	0.00	0.00	$40,484.71	False

Total Element Cost: $403,972.18

Element: UXO Mapping

Phase	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Cost	Extended Cost	Cost Override
33010202	Per Diem (per person)	588	DAY	0.00	0.00	0.00	160.00	$94,080.00	True
33040213	White's All Metals, weekly rental	84	WK	0.00	0.00	0.00	359.64	$30,209.76	True
33040651	4 X 4 Truck- Rental/Lease	168	DAY	0.00	0.00	167.27	0.00	$28,102.00	False
33040934	UXO Technician II	2,880	HR	0.00	95.64	0.00	0.00	$275,438.90	False
33040935	UXO Technician III (UXO Supervisor)	480	HR	0.00	112.46	0.00	0.00	$53,979.62	False
33041101	Airfare	7	LS	0.00	0.00	0.00	750.00	$5,250.00	True
33240101	Other Direct Costs	1	LS	19,186.53	0.00	0.00	0.00	$19,186.53	True

Total Element Cost: $506,246.80

Technology: MEC Removal Action

Element: UXO Removal

Phase	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Cost	Extended Cost	Cost Override
33010202	Per Diem (per person)	36	DAY	0.00	0.00	0.00	160.00	$5,760.00	True
33040213	White's All Metals, weekly rental	4	WK	0.00	0.00	0.00	359.64	$1,438.56	True
33040646	Backhoe - Rental/Lease	6	DAY	0.00	0.00	597.66	0.00	$3,585.97	False
33040651	4 X 4 Truck- Rental/Lease	11	DAY	0.00	0.00	167.27	0.00	$1,840.01	False
33040934	UXO Technician II	180	HR	0.00	95.64	0.00	0.00	$17,214.93	False
33040935	UXO Technician III (UXO Supervisor)	30	HR	0.00	112.46	0.00	0.00	$3,373.73	False
33041001	16oz Standard TNT Booster	6	EA	0.92	0.00	0.00	0.00	$5.52	False
33041002	50 gr/ft Det -Cord (1000 ft roll)	1	EA	1,144.46	0.00	0.00	0.00	$1,144.46	False
33041004	12 ft Lead Primadet Non- Electric Detonators	3	EA	13.73	0.00	0.00	0.00	$41.20	False
33240101	Other Direct Costs	1	LS	1,402.77	0.00	0.00	0.00	$1,402.77	True

Total Element Cost: $35,807.15

Element: Site Management

Phase	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Cost	Extended Cost	Cost Override
33010202	Per Diem (per person)	652	DAY	0.00	0.00	0.00	160.00	$104,320.00	True
33040651	4 X 4 Truck- Rental/Lease	658	DAY	0.00	0.00	167.27	0.00	$110,066.16	False
33040921	Senior UXO Supervisor (SUXOS)	940	HR	0.00	138.28	0.00	0.00	$129,982.43	False
33040923	UXO Project Manager	940	HR	0.00	203.43	0.00	0.00	$191,220.54	False

Technology: MEC Removal Action

33040930	UXO QC Specialist	940	HR	0.00	126.94	0.00	0.00	$119,325.11	False
33040931	UXO Safety Officer	940	HR	0.00	128.91	0.00	0.00	$121,170.76	False
33041101	Airfare	4	LS	0.00	0.00	0.00	750.00	$3,000.00	True

Total Element Cost: $779,084.99

Element: Stakeholder Involvement

Phase	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Cost	Extended Cost	Cost Override
33040923	UXO Project Manager	16	HR	0.00	203.43	0.00	0.00	$3,254.82	False
33040935	UXO Technician III (UXO Supervisor)	16	HR	0.00	112.46	0.00	0.00	$1,799.32	False
33041303	Site Specific Workplan (High Complexity)	1	EA	200.58	57,523.92	0.00	0.00	$57,724.49	False
33041306	Explosive Safety Submission (High Complexity)	1	EA	401.15	30,045.69	0.00	0.00	$30,446.85	False
33041315	UXO Removal Report (High Complexity)	1	EA	601.73	76,518.01	0.00	0.00	$77,119.74	False

Total Element Cost: $170,345.22

Total 1st Year Tech Cost: $1,958,303.05

Technology: Construction Support

Element:

		Unit of	Material	Labor Unit	Equipment	Sub Bid		Cost

Technology: Construction Support

Phase	Description	Quantity	Measure	Unit Cost	Cost	Unit Cost	Cost	Extended Cost	Override
33010108	Sedan, Automobile, Rental	10	DAY	0.00	0.00	0.00	94.57	$945.66	False
33010202	Per Diem (per person)	64	DAY	0.00	0.00	0.00	116.00	$7,424.00	True
33040213	White's All Metals, weekly rental	32	WK	0.00	0.00	0.00	359.64	$11,508.48	True
33040651	4 X 4 Truck- Rental/Lease	10	DAY	0.00	0.00	167.27	0.00	$1,672.74	False
33040921	Senior UXO Supervisor (SUXOS)	100	HR	0.00	113.39	0.00	0.00	$11,338.89	False
33040923	UXO Project Manager	100	HR	0.00	166.81	0.00	0.00	$16,680.94	False
33040930	UXO QC Specialist	100	HR	0.00	104.09	0.00	0.00	$10,409.21	False
33040931	UXO Safety Officer	100	HR	0.00	105.70	0.00	0.00	$10,570.21	False
33040934	UXO Technician II	100	HR	0.00	78.42	0.00	0.00	$7,842.36	False
33041001	16oz Standard TNT Booster	8	EA	0.92	0.00	0.00	0.00	$7.36	False
33041002	50 gr/ft Det -Cord (1000 ft roll)	2	EA	1,144.46	0.00	0.00	0.00	$2,288.93	False
33041004	12 ft Lead Primadet Non- Electric Detonators	4	EA	13.73	0.00	0.00	0.00	$54.93	False
33041101	Airfare	10	LS	0.00	0.00	0.00	0.00	$0.00	False
33041301	Site Specific Workplan (Low Complexity)	2	EA	200.58	26,873.59	0.00	0.00	$54,148.33	False
33041304	Explosive Safety Submission (Low Complexity)	2	EA	401.15	8,628.45	0.00	0.00	$18,059.21	False
33041313	UXO Removal Report (Low Complexity)	2	EA	200.58	27,647.36	0.00	0.00	$55,695.87	False

Total Element Cost:	$208,647.13
Total 1st Year Tech Cost:	$208,647.13

	Total Phase Element Cost	**$2,233,123.54**

Alternative 6: Surface MEC Removal with Risk Management
Phase Cost Over Time Report (with Markups)

System:

RACER Version: RACER™ Version 11.0.98.0
Database Location: C:\Users\e.rgshare\Documents\RACER\Racer.mdb

Folder:

Folder Name: West_Point

Project:

ID: 8255-5AC
Name: West Point MMRP Feasibility Studies
Category: None

Location
State / Country: NEW YORK
City: WEST POINT MILITARY RESERV

Location Modifier	Default	User	Reason for changes
	1.480	1.480	

Options
Database: Modified System Costs
Cost Database Date: 2012
Report Option: Calendar

Description Includes the development of FSs for seven MRSs located at West Point Military Reserve in New York.

Site:

ID: WSTPT-015-R-02
Name: Siege Battery - Constitution Island
Type: MMRP

Media/Waste Type

Primary: Ordnance (not residual)
Secondary: Soil

Contaminant

Primary: Ordnance (not residual)
Secondary: Ordnance (residual)

Phase Names

Pre-Study ☐
Study ☐
Design ☐
Removal/Interim Action ☐
Remedial Action ☑
Operations & Maintenance ☐
Long Term Monitoring ☑
Site Closeout ☐

Documentation

Description: 1. Alternative 1: No Action
2. Alternative 2: Risk Management
3. Alternative 3: MEC Removal to Qualify for UU/UE
4. Alternative 4: Partial Surface MEC Removal with Risk Management
5. Alternative 5: Partial Surface/Subsurface MEC Removal with Risk Management
6. Alternative 6: Complete Surface MEC Removal with Risk Management

Support Team: Patrick Reilley: Project Manager
Ali Sadrieh: Program Manager

References: The Remedial Investigation Report (Weston, 2015) and USAG West Point were used to develop the costs included in this report.

Estimator Information

Estimator Name: Jeffrey S. Miller
Estimator Title: Environmental Scientist
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Estimate Prepared Date: 02/16/2017

Estimator Signature: _____ **Date:** _____

Reviewer Information

Reviewer Name: Jarett McDonald
Reviewer Title: Project Scientist
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Alexandria, VA 22312
Telephone Number: 302.547.3876
Email Address: jmcdonald@plexsci.com

Date Reviewed: 02/16/2017

Reviewer Signature: _____ **Date:** _____

Technology Name	Technology	2017	2018	2019	2020	2021	2022
Construction Support	1	$0	$0	$0	$0	$0	$0
Five-Year Review	1	$0	$0	$0	$0	$0	$6,828
Land Use Controls	1	$57,417	$1,723	$1,723	$1,723	$1,723	$1,723
MEC Removal Action	1	$1,958,303	$0	$0	$0	$0	$0
Permitting	1	$0	$0	$0	$0	$0	$0
Total Phase Cost		$2,015,720	$1,723	$1,723	$1,723	$1,723	$8,551

Technology Name	Technology	2023	2024	2025	2026	2027	2028
Construction Support	1	$0	$0	$0	$0	$0	$0
Five-Year Review	1	$0	$0	$0	$0	$6,828	$0
Land Use Controls	1	$1,723	$1,723	$1,723	$1,723	$1,723	$1,723
MEC Removal Action	1	$0	$0	$0	$0	$0	$0
Permitting	1	$0	$0	$0	$0	$0	$0
Total Phase Cost		$1,723	$1,723	$1,723	$1,723	$8,551	$1,723

Technology Name	Technology	2029	2030	2031	2032	2033	2034
Construction Support	1	$0	$0	$104,324	$0	$0	$0
Five-Year Review	1	$0	$0	$0	$6,828	$0	$0
Land Use Controls	1	$1,723	$1,723	$1,723	$1,723	$1,723	$1,723
MEC Removal Action	1	$0	$0	$0	$0	$0	$0
Permitting	1	$0	$0	$103	$0	$0	$0
Total Phase Cost		$1,723	$1,723	$106,150	$8,551	$1,723	$1,723

Technology Name	Technology	2035	2036	2037	2038	2039	2040
Construction Support	1	$0	$0	$0	$0	$0	$0
Five-Year Review	1	$0	$0	$6,828	$0	$0	$0
Land Use Controls	1	$1,723	$1,723	$1,723	$1,723	$1,723	$1,723
MEC Removal Action	1	$0	$0	$0	$0	$0	$0
Permitting	1	$0	$0	$0	$0	$0	$0
Total Phase Cost		$1,723	$1,723	$8,551	$1,723	$1,723	$1,723

Technology Name	Technology	2041	2042	2043	2044	2045	2046
Construction Support	1	$0	$0	$0	$0	$0	$104,324
Five-Year Review	1	$0	$6,828	$0	$0	$0	$0
Land Use Controls	1	$1,723	$1,723	$1,723	$1,723	$1,723	$1,723
MEC Removal Action	1	$0	$0	$0	$0	$0	$0
Permitting	1	$0	$0	$0	$0	$0	$103
Total Phase Cost		$1,723	$8,551	$1,723	$1,723	$1,723	$106,150

Technology Name	Technology	Total					
Construction Support	1	$208,647					
Five-Year Review	1	$34,139					
Land Use Controls	1	$107,376					
MEC Removal Action	1	$1,958,303					
Permitting	1	$205					
Total Phase Cost		$2,308,671	$0	$0	$0	$0	$0