FINAL
FEASIBILITY STUDY SEACOAST BATTERY MUNITIONS RESPONSE SITE WSTPT-013-R-01 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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Contract No. W91DR-14-D-009
Task Order: 0005

January 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
DERP	Defense Environmental Restoration Program
DGM	Digital Geophysical Mapping
DGPS	Differential Global Positioning System
DMM	Discarded Military Munitions
DoD	Department of Defense
DODI	Department of Defense Instruction
EM	Engineering Manual
EMI	Electromagnetic Induction
EOD	Explosive Ordnance Disposal
EPA	Environment Protection Agency
ESA	Endangered Species Act
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
NTCRA LUCP	Non-Time Critical Removal Action Land Use Control Plan
NYNHP	New York Natural Heritage Program
NYSDEC	New York State Department of Environmental Conservation
O&M	Operation and Maintenance
PARS	PARS Environmental, Inc.

ACRONYMS AND ABBREVIATIONS (Continued)

Plexus	Plexus Scientific Corporation
Plexus/PARS	Plexus/PARS Joint Venture
PPE	Personal Protective Equipment
PRG	Preliminary Remediation Goal
RAO	Remedial action objective
RI	Remedial Investigation
SAM	Sub Audio Magnetics
SAR	Synthetic Aperture Radar
SI	Site Inspection
SOP	Standard Operating Procedure
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
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
West Point	U.S. Army Garrison West Point
Weston	Weston Solutions, Inc.

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1.0 INTRODUCTION

The United States Army Corps of Engineers (USACE) Baltimore District contracted the Plexus Scientific Corporation (Plexus)/PARS Environmental, Inc. (PARS) Joint Venture (Plexus/PARS) to complete a Feasibility Study (FS) for the Seacoast Battery (WSTPT-013-R-01) 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 Seacoast Battery MRS 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.

The Remedial Investigation (RI) and FS process was 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 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 Seacoast Battery MRS.

The next phase of the CERCLA process at the Seacoast Battery MRS was the Site Inspection (SI). The SI field activities at the Seacoast Battery MRS were conducted in spring 2006, and included approximately 4.4 linear miles of visual surveys and the collection of one soil sample for MC analysis. No MEC or munitions debris (MD) was observed during the visual surveys. Because no evidence of military munitions was observed at the MRS during the visual survey, one soil sample (the minimum required) was collected from a small depression that could have been an impact crater. The sample was analyzed for Target Compound List (TCL) explosives by Method 8330 and a subset of the Target Analyte List (TAL) metals by Methods SW846 6010B and 7471A. Metals were selected for analysis based on the metals known to be associated with the munitions that West Point historically used. The metals analyzed included antimony, copper, iron, lead, mercury, potassium, and zinc. Because background data were not available for the West Point

area, the analytical results for seven TAL metals and TCL explosives were compared (for evaluation purposes only) against EPA Region 9 preliminary remediation goals (PRGs) for residential soil, where available. MC was not detected above EPA Region 9 PRGs for residential soil. The SI recommended further evaluation of the Seacoast Battery MRS for MEC during the RI phase of the CERCLA process. The SI report also recommended no further action for MC unless high concentrations of MEC and MD were identified.

The RI (Weston Solutions, Inc.[Weston], 2014) field work 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 Seacoast Battery MRS. During the RI characterization, it was confirmed that MC investigations were not warranted. As a result of the discovery of one MEC item and multiple MD items during the RI, the MRS was recommended to undergo an FS.

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 the 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 from 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).

1.2 West Point and Seacoast Battery Munitions Response Site Description and History

West Point is located in Orange and Putnam Counties, New York, on the west bank of 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 or campus, 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.

The Seacoast Battery MRS lies within Putnam County, across the Hudson River from the Main Post area of West Point on Constitution Island (**Figure 1-2**). Constitution Island is part of West Point and access to, and activities on, the island are controlled by the West Point. Vehicular admittance to Constitution Island is controlled by a locked gate approximately 1.2 road miles from the MRS that requires contacting the Constitution Island Caretaker to open. The Caretaker resides on the island and maintains historic features located outside the Seacoast Battery MRS. Guided walking tours of some of the historical features of the island are open to the public and are given during the summer. All tours are controlled by West Point and are scheduled through the visitors center. Tours do not enter the MRS, visitors are told to remain on the island's trails and there are no trails leading to or on the MRS.

The Seacoast Battery MRS (WSTPT-013-R-01) comprises approximately 2 acres of West Point, which is owned and managed by the U.S. Army. The Seacoast Battery MRS encompasses only land on Constitution Island. The MRS is bounded by the Siege Battery – TD River (MRS WSTPT-016-R-01) to the south (located within the Hudson River). On the west, north, and east sides, the MRS is bounded by three historic cultural areas of significance, undeveloped land containing thick brambles, and the Siege Battery – Constitution Island MRS (WSTPT-015-R-02; **Figure 1-3**).

The Seacoast Battery was constructed between 1836 and 1860 and was used by academy trainees from approximately 1860 until 1940. The battery appears on a map from 1937; however, no traces of the battery remain. The former location of the battery is not within the Seacoast Battery MRS, but under the North Dock parking lot (Weston, 2014). The battery contained several gun positions and ammunition magazines. Munitions used at the battery included large-caliber, high-explosive and practice rounds, and mortars. Activities that took place on the installation that are associated with the Seacoast Battery MRS included live firing conducted from the battery toward targets in the Hudson River (see **Figure 1-3**). The MRS is a 2-acre portion of the range buffer area, as the impact area was located within the Hudson River. The Seacoast Battery MRS is the land area on Constitution Island where the impact of projectiles may have occurred (Weston, 2014).

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 Seacoast Battery MRS, including the nature, extent, and hazards associated with MEC.

As previously mentioned in Section 1.1, MC was not detected above EPA Region 9 PRGs during the SI. Therefore, MC sampling during the RI was only planned if concentrated munitions use areas were uncovered. No concentrated munitions use areas were identified at the Seacoast Battery MRS during the intrusive investigation activities, and it was determined by the project team that further sampling for MC was not warranted (Weston, 2014).

The results of the RI are discussed in greater detail in the *Final Remedial Investigation Report for the Seacoast Battery Munitions Response Site* (Weston, 2014).

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 (Weston, 2014). A third weather pattern that influences the climate of the area 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, 2014).

Thunderstorms occur approximately 20 times per year. Tornadoes occur at a frequency of 3 to 4 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, 2014).

1.3.1.2 Geology

West Point lies in the Hudson Highlands, characterized by 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, 2014).

Precambrian-age granite, diorite, gneiss, and schist form the major crystalline bedrock underlying the Seacoast Battery 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, 2014).

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, 2014).

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 (Weston, 2014).

Site-specific geologic investigations were not conducted for the Seacoast Battery MRS. The boring data from nearby monitoring wells are not relevant because of an approximate distance of 0.5 mile. Regional geologic maps (Weston, 2014) indicate that the bedrock geology of the Seacoast Battery MRS is biotite-quartz-plagioclase gneiss underlain by biotite granitic gneiss, amphibolite, calc-silicate rock. Bedrock is very shallow with outcroppings.

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, 2014). The topography of the Seacoast Battery MRS is extremely steep with cliffs. The Seacoast Battery MRS ranges in elevation from approximately 2 feet to 20 feet above mean sea level (amsl).

1.3.1.4 Soil

The Seacoast Battery MRS is comprised entirely of Charlton loam with 8 to 15% slopes. The Charlton loam is strongly sloping, very deep and stony, and well drained. Formed from glacial till derived from granite, schist, and gneiss, and containing significant surface stones, the Charlton loam soil is susceptible to moderate erosion. Areas containing this soil are best maintained by establishing plant cover to aid in erosion control.

1.3.1.5 Hydrogeology

1.3.1.5.1 Surface Water

Although no surface water resources exist in the Seacoast Battery MRS, the MRS is bounded by the Hudson River. Constitution Island does not contain any surface water bodies; however, an approximate 19-acre freshwater emergent wetland is located approximately one-third of a mile northeast of the Seacoast Battery MRS.

1.3.1.5.2 Groundwater

More than 90% of the bedrock is composed of undifferentiated granite and gneiss of Precambrian age. The bedrock is overlain by an irregular mantle of unconsolidated till and outwash of Pleistocene age. The groundwater in Putnam County is contained in till, outwash, and bedrock. Records indicate an average yield of about 2 gallons per minute (gpm).

Because of the proximity of the Seacoast Battery MRS to the Hudson River, the groundwater level within the MRS should be approximately equal to the mean sea level of the river.

Additionally, the groundwater flows towards and recharges the Hudson River. However, the boring data from a nearby abandoned monitoring well on Constitution Island was used to ascertain relevant groundwater information. Groundwater was found to be in the Precambrian gneiss with groundwater found at 20 feet below ground surface (bgs). The well was low yield at 3 gpm. The elevation of the well at ground surface was approximately 18 feet amsl, which is equal to the elevation in portions of the Seacoast Battery MRS, thus indicating that the groundwater is consistent with the water level of the Hudson River, which varies from -4 to 7 feet amsl.

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, 2014).

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. 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* (Tetra Tech, Inc., 2011), Constitution Island supports a largely undisturbed matrix of forest, grassland, and wetlands. 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. 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, 2014).

1.3.1.6.2 Wetlands

Approximately 1,010 acres of wetlands are located throughout West Point in association with streams, ponds, depressions, and seeps. Constitution Island contains an approximate 19-acre freshwater emergent wetland and several freshwater forested/shrub wetlands that range from approximately one-third acre to approximately 2 acres; however, the Seacoast Battery MRS does not contain wetlands (Weston, 2014).

1.3.1.6.3 Flora

Vegetation in the Seacoast Battery MRS is limited to trees and thick brambles (Weston, 2014).

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 species of fish and invertebrate species (Weston, 2014). It is likely that some of these species would rely on the site for habitation since it is undeveloped.

1.3.1.6.5 Other Species of Potential Concern

Constitution Island supports a largely undisturbed matrix of forest, grassland, and wetlands. Forests cover most of the island, and primarily comprise Seacoast Battery MRS. The MRS contains steep cliffs covered with trees and thick brambles. The Seacoast Battery MRS does not contain wetlands.

The following list contains species that have the potential to exist within the Seacoast Battery MRS (Weston, 2014):

- 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 Seacoast Battery MRS. However, the *Integrated Natural Resources Management Plan for the United States Army Garrison – West Point, 2011-2015* (Tetra Tech, 2011) contains an extensive list of species that were documented on West Point and Constitution Island. There is a potential for other species known to exist on Constitution Island to traverse and/or be present on the Seacoast Battery MRS because of the similar habitat types and proximity.

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, the least bittern, and the Needham's skimmer, the remaining species have the potential to occur in the Seacoast Battery MRS. The NYNHP did not identify any federally threatened or endangered plant species in any of the West Point MRSs.

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 (Weston, 2014). The Seacoast Battery MRS contains cultural and archaeological resources, the specific locations

of which are not provided (Raley, 2016). The Seacoast Battery MRS is also bounded by three historic and culturally significant areas, including the site of a Revolutionary War encampment; the site of a former forge, "Smithy"; and a Revolutionary War parade grounds (**Figure 1-3**).

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 four land use zones based on the functional categories that reflect the West Point missions (Weston, 2014):

- Cadet Use: Academic, intramural athletic, billeting, and parading.
- Cadet Support: Intercollegiate athletic fields and some cadet support facilities.
- Post Support: 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.

Seacoast Battery MRS is located in a Recreational, Industrial, Field Training area and is open space that is used for recreational activities (e.g., hiking). There is no future construction planned for the Seacoast Battery MRS, and the future land use is expected to remain the same as current land use.

1.3.2 Munitions and Explosives of Concern

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

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

- **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 (DoD, 2008).

  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 (DoD, 2008).

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 (DoD, 2008).

1.3.2.1 Nature and Extent of Munitions and Explosives of Concern

A full-coverage mag and dig survey was performed on the accessible portions of the 2-acre Seacoast Battery MRS to delineate the nature and extent of MEC. A total of 27 subsurface anomalies were detected as a result of the survey. No surface MEC or MD were detected during the RI.

Each detected anomaly was intrusively investigated. One MEC item (UXO, a 37-millimeter [mm] MkI projectile, fuzed) and 26 MD items were recovered during intrusive investigations. The MD items included one 3-inch Stokes mortar (sand-filled) and 25 fragments from unknown munitions. The locations of the MEC and MD recovered during the RI are presented in **Figure 1-4**. MEC and MD found during the RI are presented in **Table 1-1**.

Table 1-1 Summary of Munitions and Explosives of Concern and Munitions Debris at the Seacoast Battery Munitions Response Site

Item Type	Item Description	Dig Date	Depth (inches)	Weight (pounds)
UXO	37-mm MkI projectile, fuzed	08/17/2011	2	3.0
MD	3-inch Stokes mortar (sand-filled)	08/18/2011	4	8.0
MD	25 fragments, unknown	08/16/2011 08/18/2011	1-8	36.5

Notes:
MD Munitions Debris
mm Millimeter
UXO Unexploded Ordnance

The UXO item was recovered at 2 inches bgs. The MD was recovered between 1 inch and 8 inches bgs. All UXO and MD recovered during the RI were located within the Seacoast Battery MRS. No military munitions evidence was found north of the MRS where investigations extended beyond the MRS boundary.

1.3.2.2 Munitions and Explosives of Concern Fate and Transport

Potential routes of migration at the Seacoast Battery MRS include the physical processes that may result in movement or relocation of an MEC item from its original placement. If not removed, the MEC will have the potential to pose an explosive hazard. The following physical processes can result in the transport of an MEC item from its original placement:

- Picking up or moving a potential MEC item by a person(s);
- Disturbance of potential MEC during soil moving activities; and/or
- Natural processes (e.g., erosion).

The full-coverage mag and dig surveys were performed over the majority of the MRS, with no MEC or MD found on the surface. Therefore, there is a low probability of MEC being present on the ground surface of inaccessible areas of the MRS, and it is unlikely that a person would pick up or move a potential MEC item. However, individuals (i.e., West Point personnel, contractor personnel, recreational users, or site visitors) could come in contact with potential MEC simply by walking.

The Seacoast Battery MRS is undeveloped and is not easily traversed because it is densely forested and has a steep grade. However, because the MRS does not contain barriers to enter from the Hudson River, the likelihood of a person picking up or moving a potential MEC item was considered for a conservative analysis of the potential routes of migration for MEC.

Natural erosion over time of soil by the wind or by water (surface water or precipitation) can result in the exposure of buried MEC by the removal of the overlying soil. In some cases, if soil is unstable and the erosive force is sufficient to act on the size of MEC item(s) present, this process can also result in the movement of an MEC item from its original position to another location. The topography of Seacoast Battery MRS includes steep slopes and cliffs, and the elevation ranges from approximately 2 feet to 20 feet amsl. The Charlton loam soils that covers the entirety of the Seacoast Battery MRS are susceptible to moderate erosion.

In addition to erosion, buried objects have been known to move or migrate toward the surface during freezing and thawing cycles. The movement occurs when cold penetrates the ground, and the water below the buried objects freezes and expands, gradually pushing the items upward. This phenomenon is often referred to as “frost heave” and is most likely to affect items buried above the frost line. The soil type influences the occurrence of frost heave; gravel, sand, and clay are not typically susceptible to the process, whereas silty soil is susceptible. The Charlton loam soil found at the Seacoast Battery MRS is susceptible to frost heave. The maximum frost penetration depth for the region is 1 to 1.25 meters (approximately 3.28 feet to 4 feet) bgs.

1.3.2.3 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* (MEC HA; EPA, 2008). 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 HA was used to assess the explosives hazards for the Seacoast Battery 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 MEC HA guidance document (EPA, 2008) includes an automated workbook that develops site scoring through standardized inputs and formulas. As part of the Seacoast Battery RI, the automated workbook was used to provide a MEC HA Hazard Score. A summary of the MEC HA scoring for the Seacoast Battery MRS is presented below.

Site: Seacoast Battery MRS	Hazard Level	Hazard Score
Current Use Activities	3	620

For current use activities, the Seacoast Battery MRS has a Hazard Level of 3, which indicates the MRS has moderate hazard potential. The presence of MEC at an MRS means that an explosive hazard may exist. Therefore, MEC may continue to pose a hazard at a Hazard Level 3 MRS. Typical characteristics of a Hazard Level 3 MRS include:

- DMM on the surface, or intrusive activities that overlap with minimum depths of DMM located only in the subsurface.
- Former target area, open burn/open detonation area, functional test range, or maneuver area that has undergone a surface cleanup.
- An MRS with moderate or limited accessibility, and a low number of contact hours.

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). 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 EPA MEC HA (EPA, 2008) guidance recommends that the presence of ecological resources be addressed during the CERCLA nine criteria analysis. The EPA defines ecological resources for the purposes of the MEC HA (EPA, 2008) 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 did not identify any ecological resources at the Seacoast Battery MRS; however, cultural resources are present. While the RAOs for the Seacoast Battery MRS will be primarily designed to address the overall goal of protecting human health from residual explosive hazards, impacts to

cultural resources present at the MRS will be addressed during the screening and detailed analysis of alternatives.

The entire Seacoast Battery MRS is undeveloped and forested with thick brambles and steep slopes and cliffs, where human exposure to surface and subsurface soil can occur. MEC and MD recovered during the RI were most likely the result of live firing from the former Seacoast Battery conducted toward targets in the Hudson River. Based on the MEC HA performed during the RI, the Seacoast Battery MRS has a Hazard Level of 3, which indicates the MRS has a moderate hazard potential.

The Seacoast Battery MRS is used primarily for recreational activities (e.g., hiking). Although access to Constitution Island (where the MRS is located) is limited due to a locked gate that must be accessed by contacting the Constitution Island Caretaker, human receptors are able to access the Seacoast Battery MRS by boat, as there is no barrier to access the MRS from the Hudson River.

A full-coverage mag and dig survey conducted in accessible areas at the MRS did not find surface MEC or MD; however, because there is a potential for MEC to be present on the surface in areas inaccessible during the RI or to become exposed through the natural processes of erosion and frost heave, and because West Point personnel, contractor personnel, recreational users, and site visitors have access to the MRS, both surface and subsurface exposure pathways are considered potentially complete at the Seacoast Battery MRS.

The RAOs for the Seacoast Battery MRS include:

- Reduce or eliminate direct contact of contractor personnel, installation personnel, recreational users, and site visitors with the potential future explosive hazards posed by subsurface MEC migrating to or present on the surface.
- Reduce or eliminate direct contact of contractor personnel and installation personnel with the explosive hazards posed by potential MEC in subsurface soil.

This Seacoast Battery MRS FS assembles general response actions and technologies/technology process options into implementable 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 (EPA, 1988). 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 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—Health- or risk-based restrictions on the amount or concentration of a chemical that may be found in or discharged to the environment. Chemical-specific ARARs may be used to set cleanup levels for the chemicals of concern in the designated media, or to set a safe level of discharge (i.e., air emission or wastewater discharge) where a discharge occurs as a part of the remedial action.

Location-specific ARARs—Restrictions 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—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 indicate how a selected remedial action alternative must be designed, operated, or managed.

In addition to ARARs, guidance and other non-promulgated criteria can be considered in evaluating remedial alternatives. Non-promulgated advisories, proposed rules, criteria, or guidance documents issued by federal or state government that are not legally binding and do not have the status of potential ARARs may be designated as to-be-considered (TBC) criteria. These items are TBC when determining where ARARs are not sufficiently protective of human health and the environment.

Chemical-specific ARARs were not identified for the Seacoast Battery MRS because field investigation activities did not detect MC in excess of screening criteria. Location-specific ARARs also were not identified. Therefore, only action-specific ARARs were evaluated for the Seacoast Battery MRS. Action-specific ARARs are usually technology- or activity-based requirements or limitations placed on actions taken with respect to cleanup actions, or requirements to conduct certain actions to address particular circumstances at an MRS.

Action-specific ARARs identified for the Seacoast Battery 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

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 Seacoast Battery 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 Seacoast Battery 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 EPA guidance (EPA, 1988), 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 Seacoast Battery 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. Interim LUCs were placed on the Seacoast Battery MRS in 2012 as detailed in the *Non-Time Critical Removal Action Land Use Control Plan* (NTCRA LUCP; URS/Arcadis, 2012). An Institutional Analysis (IA) was performed (**Appendix A**) 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 (URS/Arcadis, 2012) were viable for implementation at the Seacoast Battery 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. Fencing and signage were evaluated for their effectiveness, implementability and cost at the Seacoast Battery MRS. The evaluation concluded that fencing and signage are not viable for the Seacoast Battery MRS for the following reasons:

- The Seacoast Battery MRS is a remotely located area. The walking tours of historic features of Constitution Island offered during the summer months and arranged through the West Point Visitors Center are guided and do not enter the MRS, therefore the MRS may have a limited number of annual visitors.
- The full-coverage mag and dig survey conducted during the RI for the Seacoast Battery MRS identified and disposed of MEC located in accessible areas; therefore, any remaining MEC is located in inaccessible and hard to access areas.
- The Seacoast Battery MRS is located on Constitution Island (a specially managed site) and the installation of fencing and/or signage would impair the aesthetic and educational value of the area.

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

Table 3-1 Viable Land Use Control Technology Process Options Summary for the Seacoast Battery 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 item, 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, including process options that were tested and used at the Seacoast Battery MRS during the RI, 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 at the Seacoast Battery MRS
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:** Effectively detects surface MEC, but cannot detect subsurface MEC. Must be used in conjunction with another process option capable of detecting subsurface MEC. 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.	**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 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.	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 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.	**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 impact 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 sufficiently effective and implementable with costs that are not excessive.

Process Option	Technical Implementability	Effectiveness	Implementability	Cost	Representative Systems	Viability and Retention at the Seacoast Battery MRS
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.	**High:** Effectively detects surface and subsurface MEC located at the MRS. 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.	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 rock outcrops and steep terrain are not present.	**Medium:** Effectively detects surface and subsurface MEC located at the MRS in clearcut areas and areas free of rock outcrops and steep terrain. Cannot be used alone. Minor impact 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 rock outcrops and 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 sufficiently 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.	**Low:** Effectiveness limited by variable environmental and geological conditions. Requires clearcut areas and areas free of rock outcrops and 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 rock outcrops and 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 sufficiently 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 rock outcrops and steep terrain, which prevent use of the large sensors that are required.					

Process Option	Technical Implementability	Effectiveness	Implementability	Cost	Representative Systems	Viability and Retention at the Seacoast Battery MRS
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 rock outcrops and 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 cannot reliably detect single items of MEC and single items of MEC are expected at this MRS based on the results of the RI.					
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 detect subsurface MEC and subsurface MEC are expected at this MRS based on the results of the 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	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 at the Seacoast Battery MRS
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).	**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 impact 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 sufficiently 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 RIs at other MRSs. 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.	**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 impact 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 sufficiently 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 RIs conducted at other MRSs.	**Retained:** This process option is technically implementable for this MRS.	**High**: Effective positioning technology not limited by wooded or rocky terrain present at the MRS. Minimal to no impact 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 sufficiently 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. 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 Seacoast Battery 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. 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. The MSD may also be reduced if appropriate engineering controls are applied.

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 at the Seacoast Battery MRS
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.	**High**: Highly effective process option for removing the small quantity of MEC expected at this MRS. Minimal to no impact 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 anticipated depth of MEC is less (12 inches below ground surface) than that required for removal utilizing mechanical means.					
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 MRS was found to contain a low MEC density during the RI and this process option is used for high MEC density MRSs.					
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 yet 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 at the Seacoast Battery MRS
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 item. Notes: Disposition of resultant waste streams must be addressed in BIP operations planning. BIP already proven effective during the RI at this MRS.	**Retained:** This process option is technically implementable for this MRS.	**High:** Effective because it permanently eliminates the explosive hazard associated with MEC. Requires engineering controls. Major impact 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.	**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 impact 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.	**Not Retained:** This process option is not technically implementable at this MRS because the MRS was found to contain a low MEC density during the RI and this process option is used for high MEC density MRSs.					

Process Option	Technical Implementability	Effectiveness	Implementability	Cost	Representative Systems	Viability and Retention at the Seacoast Battery 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 only destroys surface MEC and has not been demonstrated to be reliable.					
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 no mobile systems currently exist for deployment to the MRS.					

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 Seacoast Battery Munitions Response Site

The viable LUC technologies and process options for the Seacoast Battery MRS are summarized in **Table 3-1**. The viable technology process options listed in **Table 3-2** through **Table 3-5** for the Seacoast Battery 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 Seacoast Battery 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 Seacoast Battery 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 Seacoast Battery MRS, and the LUCs implemented at the MRS as part of the NTCRA LUCP (URS/Arcadis, 2012) 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 (i.e., recreational) of the Seacoast Battery MRS would not change. It is important to note that the Army would respond to any future MEC discoveries at the Seacoast Battery 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

Alternative 2 would implement, on a permanent basis, the LUCs detailed in the NTCRA LUCP (URS/Arcadis, 2012). An LUCP would be prepared to detail LUC implementation at the Seacoast Battery MRS. These LUCs would include administrative mechanisms and educational controls to reduce the potential for human exposure to MEC at the Seacoast Battery MRS. The specific LUC technology process options that would be implemented include land use restrictions, master plan notations, dig permitting with on-call construction support, public advisories, and an annual review. Because this alternative would result in MEC remaining at the MRS above levels that allow for UU/UE, 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 Seacoast Battery 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. Additionally, excavation activities would require a dig permit; dig permits are discussed separately below.
- 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 would be required whenever ground is broken at the MRS. At the Seacoast Battery MRS there is a low probability of encountering MEC; therefore, worker training (e.g., a safety brochure detailing what actions to take if munitions are encountered) and on-call construction support would be required when intrusive activities are performed.
- Public Advisories—Brochures (e.g., 3Rs pamphlet) detailing the potential dangers of MEC would be developed and provided to the community.
- Annual Review—LUCs will be reviewed annually by West Point.

In the event that a suspected munition is discovered, the suspected munition would be identified (e.g., material potentially presenting an explosive hazard [MPPEH], material documented as an explosive hazard (MDEH), or material documented as safe [MDAS]) and managed by explosive ordnance disposal (EOD) personnel according to Department of Defense Instruction (DODI) 4140.62. Identified MPPEH or MDEH would be BIP or disposed by consolidated shot if EOD personnel determines that the MPPEH or MDEH is acceptable to move. If disposal operations are conducted, then exclusion zones, engineering controls, and Army guidance would be utilized to minimize explosive hazards. Following disposal operations, remaining material will be inspected and certified as MDAS or subject to further destruction procedures. The MDAS would be stored in a sealed container (e.g., 55-gallon drum) for shipment to a metal recycler for final disposition.

4.3.1 Screening of Alternative 2

- Effectiveness: This alternative would protect human health by preventing human receptor contact with MEC. This alternative would not primarily reduce the Toxicity, Mobility, or Volume (TMV) of MEC at the MRS; however, it would reduce MEC TMV 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/or the community in the short-term in those instances where MEC is discovered and disposed of. Short-term effects to the community 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.

- Implementability: The LUCs included in this alternative would be technically and administratively feasible because they have already been implemented on an interim basis by West Point. West Point has the required technical expertise and has shown that the interim LUCs are reliable and readily monitored.
- Cost: The total present value of this alternative would be $123,427. The total present value was derived from capital ($57,418), annual O&M ($48,244), and periodic ($35,167) costs based on a discount rate of 1.5% over a 30-year period.

Alternative 2—Risk Management would be effective, implementable, and the costs would be relatively low. Therefore, this alternative will be analyzed as a potential alternative for the Seacoast Battery MRS.

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

Alternative 3 would include complete removal of MEC from the entire 2-acre Seacoast Battery MRS, resulting in UU/UE qualification. 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, accident prevention plan/site safety and health plan, uniform federal policy–quality assurance project plan, explosives safety submission, 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. Access to the MRS would be restricted via land by securely locking the gates to Constitution Island and via water by performing patrols in the Hudson River to prevent boater access. 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 DODI 4140.62. 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 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, rocky, 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 DODI 4140.62.

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 DODI 4140.62.

MPPEH or MDEH identified during the handheld magnetometer and DGM surveys would be BIP or disposed by consolidated shot if a DDESB TP-18–qualified individual determines that the MPPEH or MDEH is acceptable to move. 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 explosives safety submission. Following disposal operations, remaining material will be inspected and certified as MDAS or subject to further destruction procedures. The MDAS would be stored in a sealed container (e.g., 55-gallon drum) for shipment to a metal recycler for final disposition.

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 detected at 2 inches bgs (37-mm projectile) and MD (including 3-inch stokes practice mortar) was detected from 1 inch to 8 inches bgs at the Seacoast Battery MRS. The identified munitions would be detected to a depth equivalent to 11 times their diameter or 1.4 feet bgs (37-mm projectile) and 2.8 feet below ground surface (3-inch stokes practice mortar). MEC removal would be conducted in lifts to ensure that the MRS qualifies for UU/UE.

Finally, the provisions of *Standard Operating Procedure 16-1: Protection of Archaeological or Historical Artifacts* (U.S. Military Academy [USMA], 1995) would be followed during the implementation of this alternative to protect cultural resources located near and within the MRS. These provisions would include the establishment of a 50-foot buffer zone around cultural resources and conducting any activities within the buffer zone in strict accordance with the standard operating procedure.

4.4.1 Screening of Alternative 3

- Effectiveness: This alternative would be protective of human health by removing surface and subsurface MEC 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; however, the need to clearcut the MRS would adversely affect the woodland ecosystem and cultural resources on the MRS in the short term. It may take several years for trees to re-establish themselves after clearcutting. Workers and the community 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 in the short term. 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.
- Implementability: The technology and equipment required for MEC removal can be reliably operated with readily available equipment and skilled workers; however, the potential inability to obtain approval from West Point to clearcut and grub the MRS would severely limit the implementability of this alternative. West Point may not approve this alternative because clearcutting and grubbing the MRS to remove a likely low number of MEC would significantly impact 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: The total present value of this alternative would be $446,706. The total present value was based only on a non-discounted capital cost of $446,706.

Alternative 3—Removal of MEC to Qualify for UU/UE would be effective, potentially implementable, and the costs would not be grossly excessive compared to the overall effectiveness of the alternative. Therefore, this alternative will be analyzed as a potential alternative for the Seacoast Battery MRS.

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 Seacoast Battery MRS.

5.1 Evaluation Criteria

Evaluation criteria are described in the NCP, 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 C** 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 mobility, toxicity, or volume 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* (U.S. Army, 2009), 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 Toxicity, Mobility, or Volume 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 (U.S. Army, 2009):
    - 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.
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," are 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 Seacoast Battery 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
- Alternative 3—Removal of MEC to Qualify for UU/UE

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 Seacoast Battery MRS was determined to have a MEC HA Hazard Score of 620 (moderate hazard potential; Hazard Level 3) based on the confirmed presence of MEC in the subsurface and an assumed potential presence of MEC on the surface in inaccessible areas. 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 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 community.

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 and frost heave which could move subsurface MEC 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 (the principal threat) because no action would be taken to address the MEC present at the MRS.

5. **Short-Term Effectiveness**—There would be no additional risk to workers, the community, environmental resources, or cultural resources above those posed by the MEC present because no action would be taken.

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 Seacoast Battery MRS was determined to have a MEC HA Hazard Score of 620 (moderate hazard potential; Hazard Level 3) based on the confirmed presence of MEC in the subsurface and the assumed potential presence of MEC on the surface in inaccessible areas. The MEC HA Hazard Score/Hazard Level would not change if this alternative is selected. However, the LUCs (administrative mechanisms and educational controls)—land use restrictions, master plan notation, dig permits, public advisories, and annual review—that would be implemented with selection of this alternative would reduce human receptor exposure to the explosive hazards posed by MEC at the MRS. 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 community 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 prevalent and provide an opportunity to educate the community and workers on the presence of potential munitions and provide instructions on what to do if suspected munitions are encountered.
   - The implementation of a dig permit program would educate workers on the presence of potential munitions and provide instructions on what to do if suspected munitions are encountered. In addition, the dig permit program would provide on-call construction support to properly handle and dispose of explosive hazards.
   - Land use restrictions would prevent future incompatible development (e.g., residential and/or health care facilities) 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 primarily reduce the TMV of MEC, 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 requires consolidated shot disposal, 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. The long-term effectiveness and permanence of this alternative would rely on the continued cooperation and active participation of West Point. As discussed in the IA (**Appendix A**), the LUCs included in this alternative would be supported by West Point.

   Because this alternative would result in MEC remaining at the MRS above levels that would allow for UU/UE, 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**—The LUCs of Alternative 2 would not primarily reduce the TMV of MEC at the MRS. However, the TMV of MEC would be irreversibly reduced in those instances where MEC is discovered and BIP or disposed of by consolidated shot.

5. **Short-Term Effectiveness**—There would be no additional risk to workers, the community, environment, or cultural resources at the MRS due to construction or other land-disturbance activities because no such activities are associated with this alternative. However, workers and the community 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 impact the cultural resources located within the boundaries of the Seacoast Battery MRS. However, the use of engineering controls (e.g., sand bags) during BIP or consolidated shot disposal would be utilized to reduce potential impacts to cultural resources.

   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**—The LUCs implemented at the MRS in 2012 according to the NTCRA LUCP (Arcadis/URS, 2012) and contained in this alternative would be technically and administratively feasible because the LUCs (administrative mechanisms and educational controls) recommended by the NTCRA LUCP (Arcadis/URS, 2012) are available, have been shown to be reliable (i.e., reduced human receptor exposure to explosive hazards associated with MEC at the MRS), and have been readily coordinated, funded, and reviewed by West Point.

7. **Cost**—The total present value of this alternative would be $123,427. The total present value was derived from capital ($57,418), annual O&M ($48,244), and periodic ($35,167) 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 B**.

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

Alternative 3—Removal of MEC to Qualify for UU/UE 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 3 meets the criterion for overall protectiveness of human health and the environment.

   The Seacoast Battery MRS was determined to have a MEC HA Hazard Score of 620 (moderate hazard potential; Hazard Level 3) based on the confirmed presence of MEC in the subsurface and the assumed potential presence of MEC on the surface in inaccessible areas. The implementation of this alternative would change the MEC HA Hazard Score to 325 and the MEC HA Hazard Level to 4 (low hazard potential). Removal of MEC to qualify for UU/UE at the MRS would provide long-term effectiveness and permanence by eliminating the residual explosive hazards through surface and subsurface MEC removal from the entire 2-acre MRS. Short-term effects (exposure to explosive hazards) to workers and the community during MEC removal would be minimized by using exclusion zones, engineering controls, and DDESB TP-18–qualified personnel. Additional short-term effects on workers and the community during clearcutting and grubbing (e.g., heavy equipment operation) would be minimized by preparing an accident prevention plan and site safety and health plan and by using skilled workers.

2. **Compliance with ARARs**—If discovered MEC requires consolidated shot disposal, then compliance with the substantive requirements of 40 CFR 264.401 (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 3 would provide long-term effectiveness and permanence because detected surface and subsurface MEC would be BIP or disposed by consolidated shot, thereby eliminating residual explosive hazards. No LUCs or Long-Term Management (LTM) would be required following implementation of this alternative. Because this alternative would allow for UU/UE, Five-Year Reviews would not be required.

4. **Reduction of TMV of Contaminants through Treatment**—Alternative 3 would irreversibly remove detected surface and subsurface MEC from the MRS, thereby eliminating the TMV associated with MEC at the MRS.

5. **Short-Term Effectiveness**—There would be an increased risk to workers and the community 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.

MEC disposal and clearcutting and grubbing may also negatively impact the cultural resources located near and/or within the Seacoast Battery MRS. Cultural resource impacts 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 MEC recovery and disposal. Workers will be familiar with the requirements of the SOP, including stop work and notification procedures.

6. **Implementability**—Alternative 3 would be technically feasible because the required technology, equipment, and personnel are readily available. This alternative would be administratively feasible based on Army ownership of the MRS and because personnel and equipment are available to conduct MEC removal. However, this alternative may not be administratively feasible because of the high level of coordination required between multiple entities. In addition, the required clearcutting and grubbing of the MRS would likely not be approved by West Point because the MRS is located on a specially managed site (Constitution Island) that contains sensitive and very well-preserved cultural resources dating to the Revolutionary War. These cultural resources would likely be severely impacted by the clearcutting and grubbing of the MRS.
7. **Cost**—The total present value of this alternative would be $446,706. The total present value was based only on a non-discounted capital cost of $446,706. There would be no annual O&M or periodic costs associated with this alternative because the interim LUCs would be terminated and the removal action would not require the implementation of new LUCs or a Five-Year Review. The detailed cost estimate for this alternative is provided in **Appendix B**.

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 through 3 are compared in the discussions below. Alternative 1 is not included in the comparative analysis for the modifying criteria because it does not pass the threshold criterion of Overall Protectiveness.

1. **Overall Protectiveness of Human Health and the Environment**—All of the alternatives, except Alternative 1, provide adequate 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 2 is more effective in the short term than Alternative 3 because Alternative 2 only exposes workers and the community to explosive hazards when MEC is unintentionally discovered. In addition, Alternative 2 is more effective in the short term than Alternative 3 because Alternative 2 does not expose the community or workers to the risks and explosive hazards associated with clearcutting and grubbing.

Alternative 3 would be more effective and permanent in the long term than Alternative 2 because Alternative 3 would intentionally remove surface and subsurface MEC from the MRS for UU/UE qualification.

Alternative 2 would be more implementable than Alternative 3 because West Point would not likely allow the required clearcutting and grubbing due to the presence of sensitive and very well-preserved cultural resources dating back to the Revolutionary War that are located at and/or near the MRS.

Both Alternative 2 and Alternative 3 would comply equally with ARARs.

2. **Compliance with ARARs**—Both Alternative 2 and Alternative 3 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-18–qualified personnel. Therefore, both alternatives would comply equally with ARARs. There are no ARARs associated with Alternative 1.

3. **Long-Term Effectiveness and Permanence**—Alternative 3 would provide greater long-term effectiveness and permanence than Alternative 2 because implementation of Alternative 3 would intentionally remove surface and subsurface MEC and eliminate residual explosive hazards associated with MEC on the MRS. The interim LUCs in place on the MRS have been effective and reliable since their implementation and are expected to remain effective and reliable in the future. Remaining explosive hazards to human receptors due to direct contact with residual MEC would be mitigated by the LUCs contained in Alternative 2. Alternative 2 would provide long-term effectiveness and permanence as long as the LUCs remain in place. The long-term effectiveness and permanence of Alternative 2 is dependent on the continued cooperation and active participation of West Point. Because Alternative 2 would result in MEC remaining at the MRS above levels that would allow for UU/UE, Five-Year Reviews would be performed as required by CERCLA. No Five-Year Reviews would be required for Alternative 3.

4. **Reduction of TMV of Contaminants through Treatment**—Alternative 3 would reduce the TMV of MEC more than Alternative 2 because implementation of Alternative 3 would intentionally identify and irreversibly eliminate the explosive hazard associated with all detected surface and subsurface MEC located at the MRS; however, the potential quantity

of MEC expected at the MRS is low as a result of the full-coverage mag and dig survey that was performed during the RI.

5. **Short-Term Effectiveness**—Alternative 2 would be more effective in the short term than Alternative 3 because workers and the community would only be exposed to explosive hazards when MEC is unintentionally discovered and removed from the MRS. Alternative 3 would be the least protective in the short term because clearcutting and grubbing would expose workers and the community to the risks associated with heavy equipment operation. In addition, Alternative 3 would also expose workers and the community to the explosive hazards associated with intentional MEC removal from the MRS.

6. **Implementability**—Alternative 2 and Alternative 3 would be equally implementable with respect to the availability of technology and the reliability of that technology; however, Alternative 3 would be less implementable than Alternative 2 because of the clearcutting and grubbing required to conduct surface and subsurface MEC removal. Approval to conduct clearcutting and grubbing of the MRS would likely not be granted by West Point because clearcutting and grubbing would likely severely impact the sensitive and very well-preserved cultural resources dating back to the Revolutionary War that are located at the MRS and/or on Constitution Island. Alternative 3 would also be less implementable than Alternative 2 because Alternative 3 requires considerably more coordination between multiple entities.

7. **Cost**—The total present value to perform each alternative is provided below:

    - Alternative 1 = $0
    - Alternative 2 = $123,427
    - Alternative 3 = $446,706

Table 5-1 Summary of Comparative Analysis of Alternatives

Screening Criterion		Alternative 1—No Action	Alternative 2—Risk Management	Alternative 3—Removal of MEC to Qualify for UU/UE
Threshold	Overall Protectiveness of Human Health and Environment	F	P	P
	Compliance with ARARs	P	P	P
Balancing	Long-Term Effectiveness	NA	2	1
	Reduction of TMV through Treatment	NA	2	1
	Short-Term Effectiveness	NA	1	2
	Implementability	NA	1	2
	Cost[1]	$0	$123,427	$446,706
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
NA Not analyzed because alternative did not pass the Overall Protectiveness threshold criterion screening.
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 2; where a score of 2 indicates least favorable and a score of 1 indicates most favorable.

[1] Costs are detailed in **Appendix B**.

[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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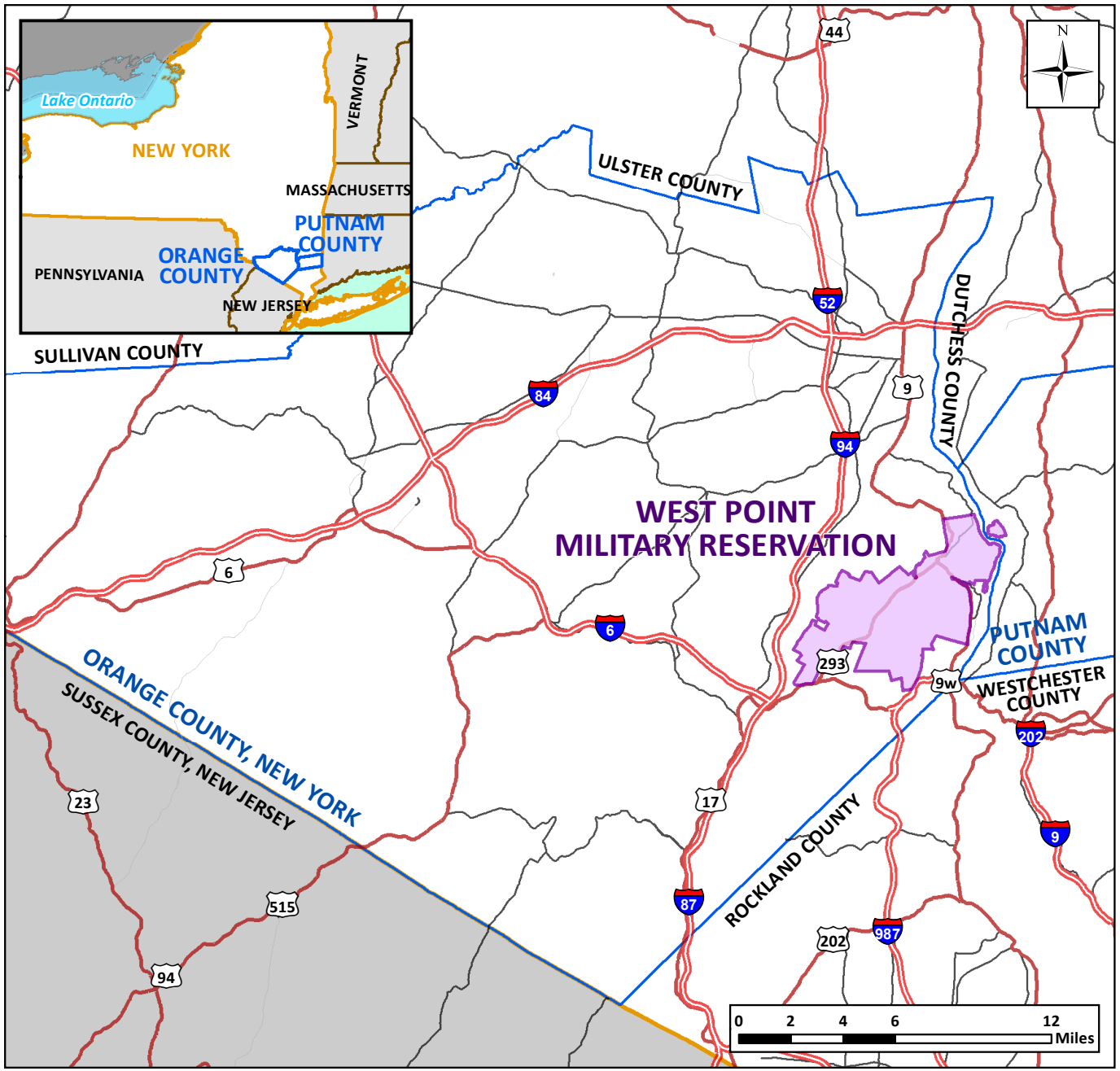

Map Key:

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

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FIGURE 1-1

Regional Location Map

Feasibility Study Seacoast Battery MRS
U.S. Army Garrison West Point
West Point, NY

H:\FILES\GIS_OPS\GIS_PRJ\West Point MMRP\Maps\Seacoast Battery FS\Figure 1-1 - West Point Location Map.mxd

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Map Key:

- County Boundary
- West Point Boundary
- Seacoast Battery Munition Response Site (MRS) Boundary

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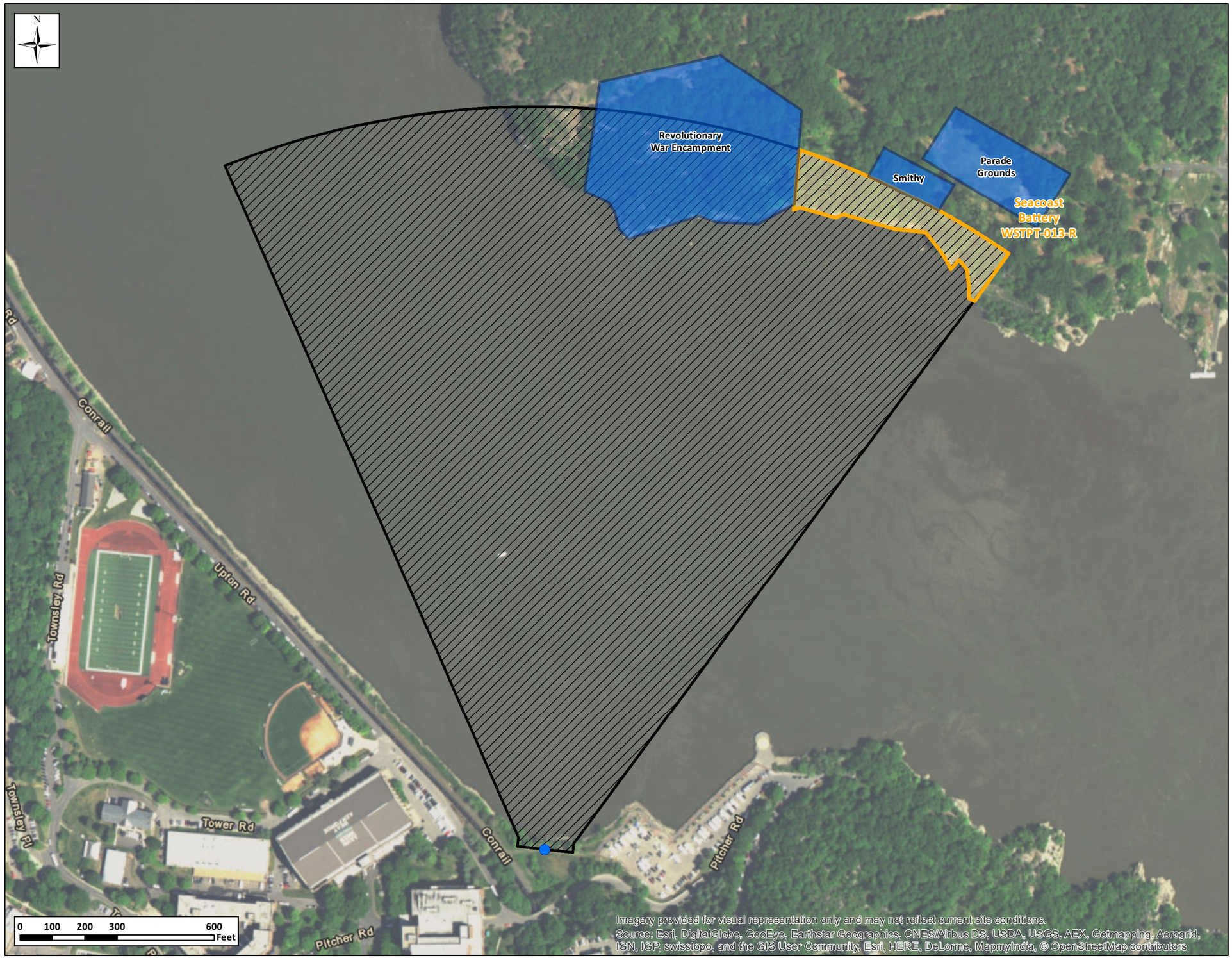
FIGURE 1-2

Seacoast Battery Munitions Response Site (MRS) (WSTPT-013-R-01)

Feasibility Study Seacoast Battery MRS U.S. Army Garrison West Point West Point, NY



Map Key:

- Seacoast Battery Munition Response Site (MRS) Boundary
- Cultural Resources
- Firing Range Fan
- Historic Firing Point

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FIGURE 1-3

Seacoast Battery MRS (WSTPT-013-R-01) Site Layout

Feasibility Study Seacoast Battery MRS
U.S. Army Garrison West Point
West Point, NY

K:\GIS_PRJ\West Point MMRP\Maps\Seacoast Battery FS\Figure 1-3 - Seacoast Battery Fan and Cultural Resources.mxd

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Map Key:

- Seacoast Battery Munition Response Site (MRS) Boundary
- 3 Stokes Mortar (empty)
- 37mm Projectile
- Frag

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FIGURE 1-4

Seacoast Battery MRS (WSTPT-013-R-01) Dig Results

Feasibility Study Seacoast Battery MRS
U.S. Army Garrison West Point
West Point, NY

K:\GIS_PRJ\West Point MMRP\Maps\Seacoast Battery FS\Figure 1-4 - Seacoast Battery Dig Results.mxd

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APPENDIX A
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 and construction support are required whenever ground is broken at each MRS. USAG West Point reviews all dig permits and requires either on-call construction support and worker training or on-site construction support during excavation activities. The determination to use on-call construction support and worker

training or on-site construction support is based on the *Probability Assessment for Determining the Probability of Encountering MEC during Site Activities at West Point, New York* (USAG West Point, 2016) which assigns each MRS to Group A or Group B based on the probability of encountering MEC. Group A MRSs present a low probability of encountering MEC and require on-call construction support and worker training (site-specific MEC awareness/safety). The site-specific MEC awareness/safety training would be provided to workers performing ground disturbing activities. The site-specific MEC awareness/safety training would identify explosives safety concerns/measures to be taken during ground disturbing activities, and the proper reporting procedures to be utilized in the highly unlikely event a MEC item is discovered. Group B MRSs present a moderate to high probability of encountering MEC 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, 2016. *Probability Assessment for Determining the Probability of Encountering MEC during Site Activities at West Point, New York*. Draft-Final, November.

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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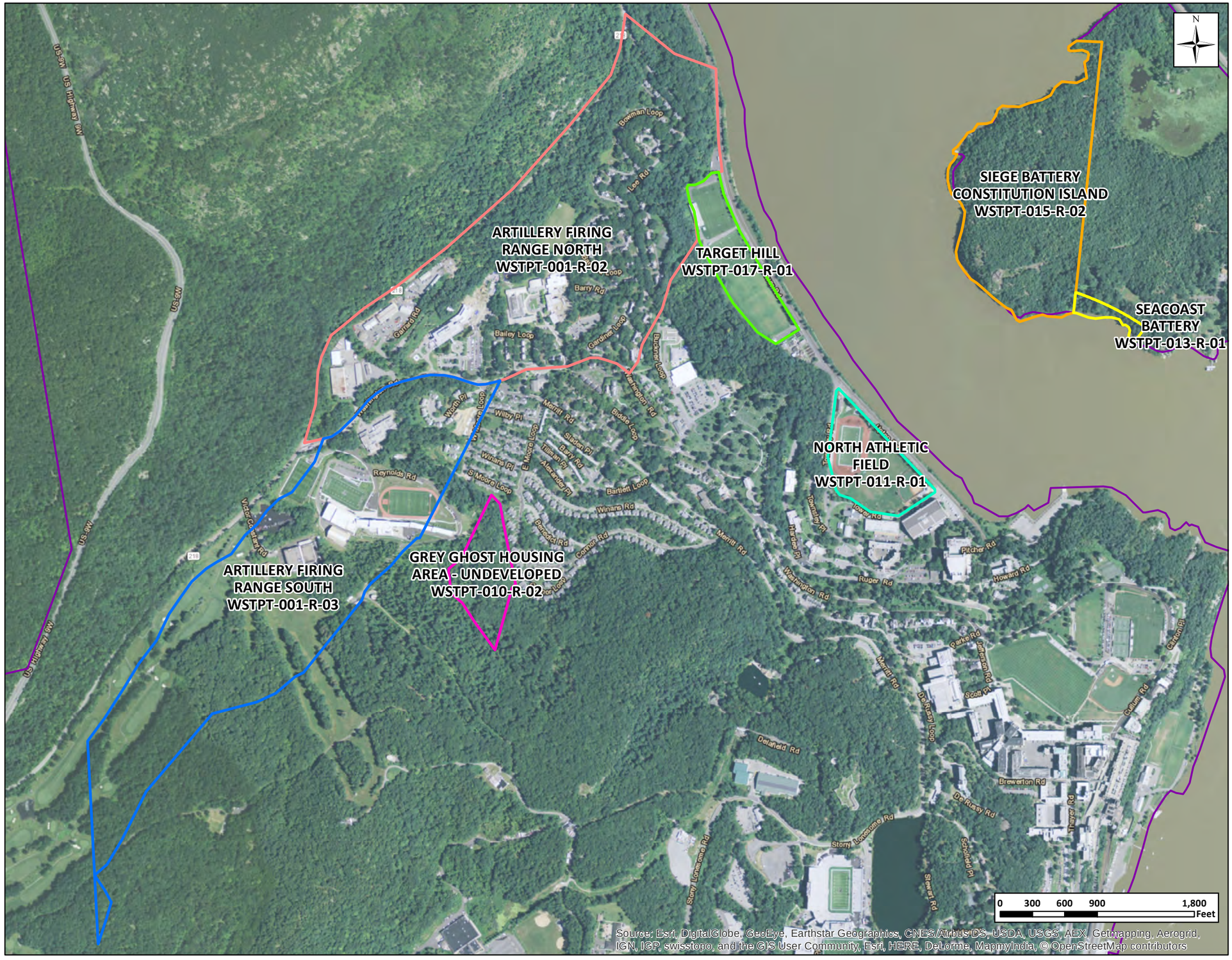

Map Key:

- 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 B
COST ESTIMATES

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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-013-R-01
Name: Seacoast Battery MRS
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: Removal of MEC to Qualify for UU/UE

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

References: The Remedial Investigation Report (Weston, 2014) 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: 08/17/2016

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: 08/18/2016

Reviewer Signature: _____ **Date:** _____

Phase Documentation:

Phase Type: Long Term Monitoring
Phase Name: 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

Total Marked-up Cost: $140,819.27

Technologies:

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

Technology: Land Use Controls

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

Technology: Land Use Controls

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 / Review

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

Technology: Five-Year Review

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	10	HR	0.00	102.69	0.00	0.00	$1,026.90	False

Total Element Cost: $1,026.90

Total 1st Year Tech Cost: $1,026.90

Total Phase Element Cost **$66,994.88**

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:

Phase Cost Over Time Report
(with Markups)

ID: WSTPT-013-R-01
Name: Seacoast Battery MRS
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: Removal of MEC to Qualify for UU/UE

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

References: The Remedial Investigation Report (Weston, 2014) 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

Phase Cost Over Time Report
(with Markups)

Business Address: 5510 Cherokee Avenue - Suite 350
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Telephone Number: 571.527.1224
Email Address: jmiller@plexsci.com

Estimate Prepared Date: 08/17/2016

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: 08/18/2016

Reviewer Signature: _____ **Date:** _____

Phase Cost Over Time Report
(with Markups)

Technology Name	Technology	2017	2018	2019	2020	2021	2022
Five-Year Review	1	$0	$0	$0	$0	$0	$6,828
Land Use Controls	1	$27,547	$29,871	$1,723	$1,723	$1,723	$1,723
Permitting	1	$1,027	$0	$0	$0	$0	$0
Total Phase Cost		$28,574	$29,871	$1,723	$1,723	$1,723	$8,551

Phase Cost Over Time Report
(with Markups)

Technology Name	Technology	2023	2024	2025	2026	2027	2028
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

Phase Cost Over Time Report
(with Markups)

Technology Name	Technology	2029	2030	2031	2032	2033	2034
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	$0	$0	$0	$0
Total Phase Cost		$1,723	$1,723	$1,723	$8,551	$1,723	$1,723

Phase Cost Over Time Report
(with Markups)

Technology Name	Technology	2035	2036	2037	2038	2039	2040
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

Phase Cost Over Time Report
(with Markups)

Technology Name	Technology	2041	2042	2043	2044	2045	2046
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	$0
Total Phase Cost		$1,723	$8,551	$1,723	$1,723	$1,723	$1,723

Phase Cost Over Time Report
(with Markups)

Technology Name	Technology	Total					
Five-Year Review	1	$34,139					
Land Use Controls	1	$105,653					
Permitting	1	$1,027					
Total Phase Cost		$140,819	$0	$0	$0	$0	$0

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-013-R-01
Name: Seacoast Battery MRS
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: Removal of MEC to Qualify for UU/UE

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

References: The Remedial Investigation Report (Weston, 2014) and USAG West Point were used to develop the costs included in this report.

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Telephone Number: 571.527.1224
Email Address: jmiller@plexsci.com

Estimate Prepared Date: 08/17/2016

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: 08/18/2016

Reviewer Signature: _____ **Date:** _____

Phase Documentation:

Phase Type: Remedial Action
Phase Name: MEC Removal to Qualify for UU/UE
Description: The 2-acre Seacoast Battery MRS will be clearcut and grubbed and cleared of all surface/subsurface MEC.

Approach: Ordnance Removal
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

Total Marked-up Cost: $446,705.60

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
17010210	Site clearing trees, with 335 H.P.	200	EA	0.00	6.74	8.55	0.00	$3,057.86	False

Technology: Clear and Grub

	dozer, to 6" diameter								
17010211	Site clearing trees, with 335 H.P. dozer, to 12" diameter	50	EA	0.00	12.58	15.96	0.00	$1,426.98	False
17010314	Grub stumps, with 335 H.P. dozer, to 6" diameter	200	EA	0.00	4.72	5.98	0.00	$2,140.46	False
17010315	Grub stumps, with 335 H.P. dozer, to 12" diameter	50	EA	0.00	7.55	12.71	0.00	$1,013.18	False
17010403	Chipping brush, heavy brush	2	ACR	0.00	7,547.64	1,781.21	0.00	$18,657.71	False
17010501	Grub and stack, 140 H.P. dozer	403	CY	0.00	7.55	3.99	0.00	$4,653.72	False
17030226	988, 7.0 CY, Wheel Loader	4	HR	0.00	168.17	238.68	0.00	$1,627.40	False
17030295	35 Ton, 769, Off-highway Truck	7	HR	0.00	156.52	250.28	0.00	$2,847.56	False
33010118	Mobilize/Demobilize Dozer, Loader, Backhoe or Excavator, 70 H.P. to 150 H.P., up to 50 miles	4	LS	0.00	256.69	226.09	0.00	$1,931.11	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	34.22	$34.22	False
33040934	UXO Technician II	40	HR	0.00	95.64	0.00	0.00	$3,825.54	False

Total Element Cost: $41,288.52

Total 1st Year Tech Cost: $41,288.52

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

Technology: MEC Removal Action

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)	1	DAY	0.00	0.00	0.00	160.00	$160.00	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)	10	HR	0.00	112.46	0.00	0.00	$1,124.58	False
33041101	Airfare	1	LS	0.00	0.00	0.00	750.00	$750.00	True
33220213	Surveying - 3-man Crew	1	DAY	0.00	3,940.00	33.41	0.00	$3,973.42	False
33240101	Other Direct Costs	1	LS	442.01	0.00	0.00	0.00	$442.01	True

Total Element Cost: $14,634.68

Technology: MEC Removal Action

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)	68	DAY	0.00	0.00	0.00	160.00	$10,880.00	True
33021530	Differential GPS Unit Rental	2	MO	469.98	0.00	0.00	0.00	$939.95	False
33040210	Geonics EM-61 Metal Locator, Towed (Weekly Rental)	1	WK	0.00	0.00	0.00	788.94	$788.94	False
33040213	White's All Metals, weekly rental	11	WK	0.00	0.00	0.00	359.64	$3,956.04	True
33040651	4 X 4 Truck- Rental/Lease	22	DAY	0.00	0.00	167.27	0.00	$3,680.02	False
33040653	All Terrain Vehicle (ATV) - Rental/Lease	1	DAY	0.00	0.00	0.00	319.36	$319.36	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	300	HR	0.00	95.64	0.00	0.00	$28,691.55	False
33040935	UXO Technician III (UXO Supervisor)	70	HR	0.00	112.46	0.00	0.00	$7,872.03	False
33040936	Geophysicist (UXO)	20	HR	0.00	183.39	0.00	0.00	$3,667.81	False
33041101	Airfare	10	LS	0.00	0.00	0.00	750.00	$7,500.00	True
33240101	Other Direct Costs	1	LS	3,022.47	0.00	0.00	0.00	$3,022.47	True

Total Element Cost: $72,166.50

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)	29	DAY	0.00	0.00	0.00	160.00	$4,640.00	True

Technology: MEC Removal Action

33040149	Nonsparking UXO Shovels	7	EA	122.59	0.00	0.00	0.00	$858.11	False
33040213	White's All Metals, weekly rental	5	WK	0.00	0.00	0.00	359.64	$1,798.20	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	9	DAY	0.00	0.00	167.27	0.00	$1,505.46	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)	30	HR	0.00	112.46	0.00	0.00	$3,373.73	False
33040936	Geophysicist (UXO)	20	HR	0.00	183.39	0.00	0.00	$3,667.81	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	1,265.93	0.00	0.00	0.00	$1,265.93	True

Total Element Cost: $32,152.12

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)	68	DAY	0.00	0.00	0.00	160.00	$10,880.00	True
33040651	4 X 4 Truck- Rental/Lease	77	DAY	0.00	0.00	167.27	0.00	$12,880.08	False
33040921	Senior UXO Supervisor (SUXOS)	110	HR	0.00	138.28	0.00	0.00	$15,210.71	False
33040923	UXO Project Manager	110	HR	0.00	203.43	0.00	0.00	$22,376.87	False
33040930	UXO QC Specialist	110	HR	0.00	126.94	0.00	0.00	$13,963.58	False
33040931	UXO Safety Officer	110	HR	0.00	128.91	0.00	0.00	$14,179.56	False

Technology: MEC Removal Action

33041101	Airfare	4	LS	0.00	0.00	0.00	750.00	$3,000.00	True

Total Element Cost: $92,490.80

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: $405,417.08

Total Phase Element Cost **$446,705.60**

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:

Phase Cost Over Time Report
(with Markups)

ID: WSTPT-013-R-01
Name: Seacoast Battery MRS
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: Removal of MEC to Qualify for UU/UE

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

References: The Remedial Investigation Report (Weston, 2014) 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

Phase Cost Over Time Report
(with Markups)

Business Address: 5510 Cherokee Avenue - Suite 350
Alexandria, VA 22312
Telephone Number: 571.527.1224
Email Address: jmiller@plexsci.com

Estimate Prepared Date: 08/17/2016

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: 08/18/2016

Reviewer Signature: _____ **Date:** _____

Phase Cost Over Time Report
(with Markups)

Technology Name	Technology	2017	Total				
Clear and Grub	1	$41,289	$41,289				
MEC Removal Action	1	$405,417	$405,417				
Total Phase Cost		$446,706	$446,706	$0	$0	$0	$0

APPENDIX C

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

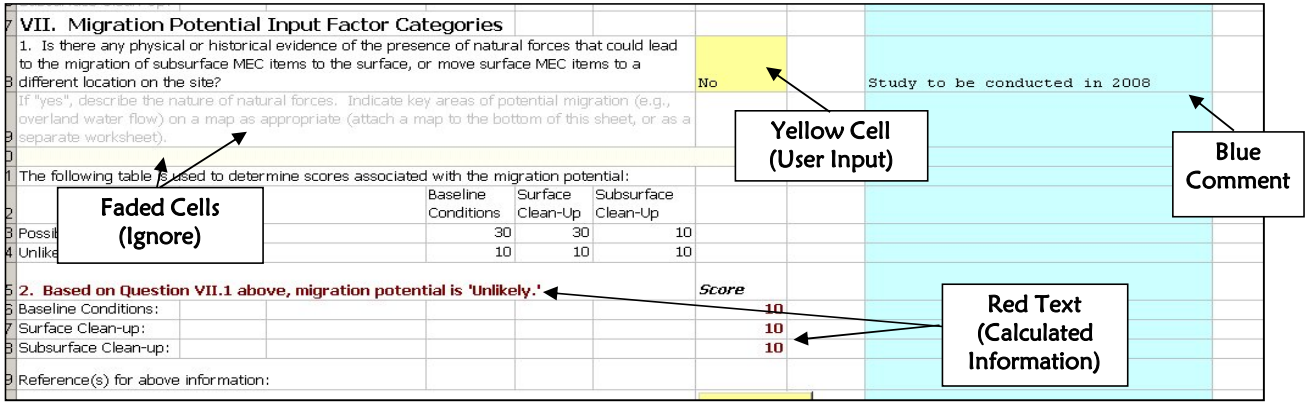
1. Open this file. Enable macros if prompted to do so. This spreadsheet will not work if your security setting is set to 'high' or 'very high'. To change your security level, go to the menu bar and select Tools/Macro/Security. Then close and reopen this spreadsheet.

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.

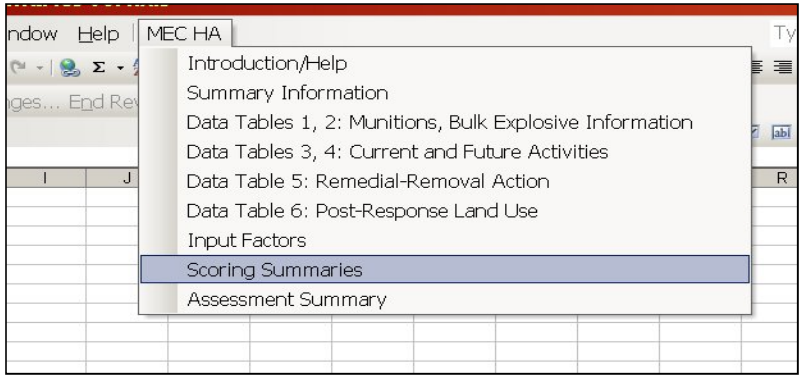
The remaining 3 sheets calculate and summarize the scores. The ***Input Factors*** sheet performs the Input Factor Score calculations, which are summarized in the ***Scoring Summaries*** sheet. The ***Hazard Level*** sheet presents the Hazard Level Category for current use activities, future use activities,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

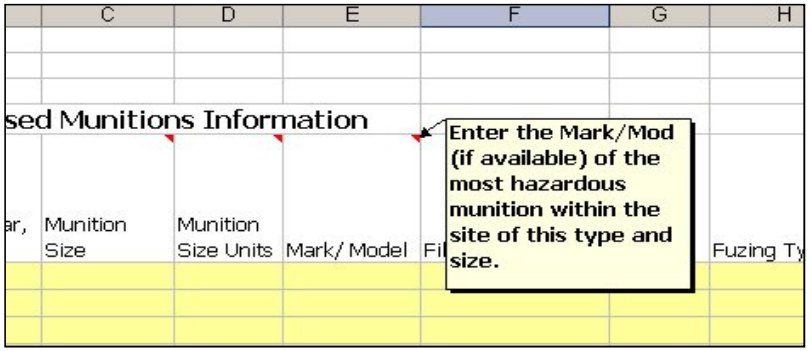


The computer will calculate information based on your inputs. Calculated information

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: Seacoast Battery
Date: 3/9/2016

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-01) Seacoast Battery MRS

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	Remedial Investigation, Final, 2014
4	
5	
6	
7	
8	
9	
10	
11	
12	

B. Briefly describe the site:

1. Area (include units): Approximately 2.0 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 Seacoast Battery that is not overlapped by other range fans. The Hudson River bounds to the south.

6. How certain are the site boundaries?

Confident in Boundaries

Reference(s) for Part B:

[redacted]

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:

[redacted]

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

Site ID: **Seacoast Battery**
Date: **3/9/2016**

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	Artillery	37	mm	Mark I	High Explosive	Yes	Impact	UNK	0.16	Subsurface Only	Fuzed projectile BIP
2	Artillery		mm	Mark I	High Explosive	Yes	Impact	UNK	0	Surface and Subsurface	This item consists of a munition suspected to exist within the MRS, to address the hazard of surface MEC, since no actual MEC were identified on the surface.
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16											
17											
18											
19											
20											

Reference(s) for table above:

[redacted]

Bulk Explosive Information

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

Reference(s) for table above:

[redacted]

Site ID: **Seacoast Battery**
Date: **3/9/2016**

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						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
	Total Potential Contact Time (receptor hrs/yr):			**365**		
	Maximum intrusive depth at site (ft):				**0**	

Reference(s) for table above:

[redacted]

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:

Site ID: **Seacoast Battery**
Date: **3/9/2016**

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	Includes LUCP, awareness program, brochures, videos, and UXO Construction Support
3	UU/UE		Moderate Accessibility	No	cleanup of MECs located both on the surface and subsurface	
4						
5						
6						

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:

[redacted]

Site ID: **Seacoast Battery**
Date: **3/9/2016**

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:

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:

Land Use Activities Planned After Response Alternative #3: UU/UE

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:

Land Use Activities Planned After Response Alternative #4:

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:

Land Use Activities Planned After Response Alternative #5:

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:

Land Use Activities Planned After Response Alternative #6:

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:

Site ID: **Seacoast Battery**

Date: **3/9/2016**

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**

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?	225 feet	Intentional detonations, hazardous fragment distance.
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

[redacted]

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

Comments

	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**

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

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**

Future Use Activities

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

Baseline Conditions:
Surface Cleanup:
Subsurface Cleanup:

Reference(s) for above information:

[redacted]

Response Alternative No. 1: No Action

Based on the 'Planned Remedial or Removal Actions' Worksheet, this alternative will lead to 'Moderate Accessibility'.

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

Response Alternative No. 2: Risk Management

Based on the 'Planned Remedial or Removal Actions' Worksheet, this alternative will lead to 'Moderate Accessibility'.

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

Response Alternative No. 3: UU/UE

Based on the 'Planned Remedial or Removal Actions' Worksheet, this alternative will lead to 'Moderate Accessibility'.

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

Response Alternative No. 4:

Please enter site accessibility information in the 'Planned Remedial or Removal Actions' Worksheet to continue.

Baseline Conditions:
Surface Cleanup:
Subsurface Cleanup:

Response Alternative No. 5:

Please enter site accessibility information in the 'Planned Remedial or Removal Actions' Worksheet to continue.

Baseline Conditions:
Surface Cleanup:
Subsurface Cleanup:

Response Alternative No. 6:

Please enter site accessibility information in the 'Planned Remedial or Removal Actions' Worksheet to continue.

Baseline Conditions:
Surface Cleanup:
Subsurface Cleanup:

Potential Contact Hours Input Factor Categories

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: **365** receptor hrs/yr

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

Future Use Activities:

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

Based on the table above, this corresponds to a input factor score of: Score

Response Alternative No. 1: No Action

Based on the 'Planned Remedial or Removal Actions' Worksheet, land use activities will not change if this alternative is implemented.

Total Potential Contact Time, based on the contact time listed for current use activities (see 'Current and Future Activities' Worksheet) **365**

Based on the table above, this corresponds to input factor scores of: ***Score***

Baseline Conditions: **15**

Surface Cleanup: **10**

Subsurface Cleanup: **5**

Response Alternative No. 2: Risk Management

Based on the 'Planned Remedial or Removal Actions' Worksheet, land use activities will not change if this alternative is implemented.

Total Potential Contact Time, based on the contact time listed for current use activities (see 'Current and Future Activities' Worksheet) **365**

Based on the table above, this corresponds to input factor scores of: ***Score***

Baseline Conditions: **15**

Surface Cleanup: **10**

Subsurface Cleanup: **5**

Response Alternative No. 3: UU/UE

Based on the 'Planned Remedial or Removal Actions' Worksheet, land use activities will not change if this alternative is implemented.

Total Potential Contact Time, based on the contact time listed for current use activities (see 'Current and Future Activities' Worksheet) **365**

Based on the table above, this corresponds to input factor scores of: ***Score***

Baseline Conditions: **15**

Surface Cleanup: **10**

Subsurface Cleanup: **5**

Response Alternative No. 4:

Not enough information has been entered in the 'Planned Remedial or Removal Actions' Worksheet. Please complete the table before returning to this section.

Total Potential Contact Time

Based on the table above, this corresponds to input factor scores of: ***Score***

Baseline Conditions:

Surface Cleanup:

Subsurface Cleanup:

Response Alternative No. 5:

Not enough information has been entered in the 'Planned Remedial or Removal Actions' Worksheet. Please complete the table before returning to this section.

Total Potential Contact Time

Based on the table above, this corresponds to input factor scores of: **Score**

Baseline Conditions:

Surface Cleanup:

Subsurface Cleanup:

Response Alternative No. 6:

Not enough information has been entered in the 'Planned Remedial or Removal Actions' Worksheet. Please complete the table before returning to this section.

Total Potential Contact Time

Based on the table above, this corresponds to input factor scores of: **Score**

Baseline Conditions:

Surface Cleanup:

Subsurface Cleanup:

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: ft

Not enough information has been entered to determine the input factor category. ***Score***

Response Alternative No. 1: No Action

Expected minimum MEC depth (from the 'Planned Remedial or Removal Actions' Worksheet): **0** ft

Based on the 'Planned Remedial or Removal Actions' Worksheet, land use activities will not change if this alternative is implemented.

Maximum Intrusive Depth, based on the maximum intrusive depth listed for current use activities (see 'Current and Future Activities' Worksheet) **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.'

	Score
Baseline Conditions:	**240**
Surface Cleanup:	
Subsurface Cleanup:	

Response Alternative No. 2: Risk Management

Expected minimum MEC depth (from the 'Planned Remedial or Removal Actions' Worksheet): **0** ft

Based on the 'Planned Remedial or Removal Actions' Worksheet, land use activities will not change if this alternative is implemented.

Maximum Intrusive Depth, based on the maximum intrusive depth listed for current use activities (see 'Current and Future Activities' Worksheet) **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.'

	Score
Baseline Conditions:	**240**
Surface Cleanup:	
Subsurface Cleanup:	

Response Alternative No. 3: UU/UE

Expected minimum MEC depth (from the 'Planned Remedial or Removal Actions' Worksheet): ft

Based on the 'Planned Remedial or Removal Actions' Worksheet, land use activities will not change if this alternative is implemented.

Maximum Intrusive Depth, based on the maximum intrusive depth listed for current use activities (see 'Current and Future Activities' Worksheet) **0** ft

Not enough information has been entered to calculate this input factor.

Score

Baseline Conditions:
Surface Cleanup:
Subsurface Cleanup: **#N/A**

Response Alternative No. 4:

Expected minimum MEC depth (from the 'Planned Remedial or Removal Actions' Worksheet): ft

Not enough information has been entered in the 'Planned Remedial or Removal Actions' Worksheet. Please complete the table before returning to this section.

Maximum Intrusive Depth ft

Not enough information has been entered to calculate this input factor.

Score

Baseline Conditions:
Surface Cleanup:
Subsurface Cleanup:

Response Alternative No. 5:

Expected minimum MEC depth (from the 'Planned Remedial or Removal Actions' Worksheet): ft

Not enough information has been entered in the 'Planned Remedial or Removal Actions' Worksheet. Please complete the table before returning to this section.

Maximum Intrusive Depth ft

Not enough information has been entered to calculate this input factor.

Score

Baseline Conditions:
Surface Cleanup:
Subsurface Cleanup:

Response Alternative No. 6:

Expected minimum MEC depth (from the 'Planned Remedial or Removal Actions' Worksheet): ft

Not enough information has been entered in the 'Planned Remedial or Removal Actions' Worksheet. Please complete the table before returning to this section.

Maximum Intrusive Depth ft

Not enough information has been entered to calculate this input factor.

Score

Baseline Conditions:
Surface Cleanup:
Subsurface Cleanup:

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:

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: No

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

At least one item listed in the 'Munitions, Bulk Explosive Info' Worksheet was identified as 'fuzed'.

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

UXO	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'.

	Score
Baseline Conditions:	**110**
Surface Cleanup:	**110**
Subsurface Cleanup:	**110**

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:	Seacoast Battery	a. Scoring Summary for Current Use Activities	
Date:	3/9/2016	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	110
IX. MEC Size		Small	40
		Total Score	**620**
		Hazard Level Category	**3**

Site ID:	Seacoast Battery	b. Scoring Summary for Future Use Activities	
Date:	3/9/2016	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			
VII. Migration Potential		Possible	30
VIII. MEC Classification		UXO	110
IX. MEC Size		Small	40
		Total Score	**310**
		Hazard Level Category	**4**

Site ID:	Seacoast Battery	c. Scoring Summary for Response Alternative 1: No Action	
Date:	3/9/2016	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	110
IX. MEC Size		Small	40
		Total Score	**620**
		Hazard Level Category	**3**

Site ID:	Seacoast Battery	d. Scoring Summary for Response Alternative 2: Risk Management	
Date:	3/9/2016	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	110
IX. MEC Size		Small	40
		Total Score	**620**
		Hazard Level Category	**3**

Site ID:	Seacoast Battery	e. Scoring Summary for Response Alternative 3: UU/UE	
Date:	3/9/2016	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			
VII. Migration Potential		Possible	10
VIII. MEC Classification		UXO	110
IX. MEC Size		Small	40
		Total Score	**325**
		Hazard Level Category	**4**

Site ID:	Seacoast Battery	f. Scoring Summary for Response Alternative 4:	
Date:	3/9/2016	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	
IX. MEC Size		Small	
		Total Score	
		Hazard Level Category	

Site ID:	Seacoast Battery	g. Scoring Summary for Response Alternative 5:	
Date:	3/9/2016	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	
IX. MEC Size		Small	
		Total Score	
		Hazard Level Category	

Site ID:	Seacoast Battery	h. Scoring Summary for Response Alternative 6:	
Date:	3/9/2016	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	
IX. MEC Size		Small	
		Total Score	
		Hazard Level Category	

MEC HA Hazard Level Determination		
Site ID: Seacoast Battery **Date:** 3/9/2016	**Hazard Level Category**	**Score**
a. Current Use Activities	3	620
c. Response Alternative 1: No Action	3	620
d. Response Alternative 2: Risk Management	3	620
e. Response Alternative 3: UU/UE	4	325

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
Are significant ecological resources located within the MRS or within the ESQD arc?	Yes

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