16 JUNE 2014

FINAL

REMEDIAL INVESTIGATION REPORT

FORMER CAPE POGE LITTLE NECK BOMB TARGET
AREA OF INVESTIGATION
MARTHA'S VINEYARD, MASSACHUSETTS

FUDS Project No. D01MA0595
Contract No. W912DY-04-D-0019
Task Order No. 0006

Prepared for:
U. S. ARMY CORPS OF ENGINEERS
NEW ENGLAND DISTRICT

Prepared by:
UXB International, Inc.

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ACRONYMS

µ	micro(s)
ADR	Automated Data Review
AirMag	airborne magnetometry
AOI	Area of Investigation
Aqua Survey	Aqua Survey, Inc.
ARAR	applicable or relevant and appropriate requirements
BERA	Baseline Ecological Risk Assessment
bgs	below ground surface
BIP	blow-in-place
CEC	cation exchange capacity
CENAE	United States Army Corps of Engineers, New England District
CERCLA	Comprehensive Environment Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CHE	Chemical Hazard Evaluation
CHF	Contaminant Hazard Factor
cm	centimeter(s)
CMR	Code of Massachusetts Regulations
COC	chain of custody
COPC	chemical of potential concern
COPEC	chemical of potential ecological concern
C_s	soil concentration of the COPEC
CSM	conceptual site model
CWM	chemical warfare materiel
DDESB	Department of Defense Explosives Safety Board
DGM	Digital Geophysical Mapping
DNT	dinitrotoluene
DoD	United States Department of Defense
DQO	Data Quality Objective
EcoSSL	Ecological Soil Screening Level
EHE	Explosive Hazard Evaluation
EM	electromagnetic
EPC	exposure point concentration
ERA	ecological risk assessment
ESL	Ecological Screening Level
ESP	Explosives Siting Plan
ESV	Ecological Screening Value
EZ	exclusion zone
°F	degree(s) Fahrenheit
FDEM	Frequency Domain Electromagnetic
FIR	food ingestion rate
FS	Feasibility Study
ft	foot or feet
FUDS	Formerly Used Defense Site
GIS	Geographic Information System

GPO	geophysical prove-out
GPS	global positioning system
GSV	geophysical system verification
H	high (in reference to Health Hazard Evaluation module)
HA	hazard assessment
HFD	hazardous fragment distance
HHE	Health Hazard Evaluation
HHRA	Human Health Risk Assessment
HMX	1,3,5,7-tetranitro-1,3,5,7-tetrazocine
HQ	hazard quotient
IDW	investigation derived waste
in.	inch(es)
INPR	Inventory Project Report
ISO	industry standard object
IVS	instrument verification strip
kg	kilogram(s)
kg dw/kg-day	kg dry weight of food per kg body weight per day
K_H	Henry's Law Constant
kHz	kilohertz
K_{OC}	organic carbon partition coefficient
L	low (in reference to Health Hazard Evaluation module)
L/kg	liters per kilogram
LANL	Los Alamos National Laboratory
m	meter(s)
M	medium (in reference to Health Hazard Evaluation module)
MADEP	Massachusetts Department of Environmental Protection
MA NHESP	Massachusetts Natural Heritage Endangered Species Program
MC	munitions constituent
MCL	Maximum Contaminant Level
MCP	Massachusetts Contingency Plan
MD	munitions debris
MFD-H	maximum fragmentation distance, horizontal
MEC	munitions and explosives of concern
mg/kg	milligrams per kilogram
mg/kg-day	mg per kg body weight per day
mg/L	milligrams per liter
MGFD	munitions with the greatest fragmentation distance
MK	Mark
MMRP	Military Munitions Response Program
MPF	migration pathway factor
MPPEH	Material Potentially Presenting an Explosive Hazard
MRA	Munitions Response Area
MRS	Munitions Response Site
MRSPP	Munitions Response Site Prioritization Protocol
MSD	minimum separation distance

msl	mean sea level
mV	millivolts
NAEVA	NAEVA Geophysics, Inc.
NG	nitroglycerin
P	ingestion rate of soil as a proportion of food ingestion rate
PA	Preliminary Assessment
PAR	Pathway Analysis Report
PETN	pentaerythrite tetranitrate
QA	quality assurance
QC	quality control
QSM	Quality Systems Manual
RAGS	Risk Assessment Guide for Superfund
RDX	1,3,5-trinitro-1,3,5-triazine
RF	receptor factor
redox	reduction oxidation
RI	Remedial Investigation
RL	reporting limit
%RSD	percent relative standard deviation
RSL	Regional Screening Level
RTK	real time kinematic
SLERA	Screening Level Ecological Risk Assessment
SUXOS	Senior Unexploded Ordnance Supervisor
TBC	to be considered
TBC	to be considered
TCRA	Time Critical Removal Action
TestAmerica	TestAmerica, Inc.
TNT	2,4,6 - trinitrotoluene
TPP	Technical Project Planning
TTOR	The Trustees of Reservations
U.S.	United States
UCL	upper confidence limit
USACE	United States Army Corps of Engineers
USAESCH	United States Army Engineering Support Center, Huntsville
USDA-SCS	United States Department of Agriculture – Soil Conservation Service
USEPA	United States Environmental Protection Agency
UXB	UXB International, Inc.
UXO	unexploded ordnance
UXOQCS	Unexploded Ordnance Quality Control Specialist
UXOSO	Unexploded Ordnance Safety Officer
VOC	volatile organic compound
VRH	VRHabilis, LLC
TRV	toxicity reference value
WAAS	Wide Area Augmentation System
ww	wet weigh

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1.0 EXECUTIVE SUMMARY

1.0.1 Between 14 December 2010 and 2 November 2011, UXB International, Inc. (UXB) and its subcontractors conducted a Remedial Investigation (RI) at the Former Cape Poge Little Neck Bomb Target Area of Investigation (AOI), which will be referred to hereinafter as the AOI. UXB prepared this document under contract to the U.S. Army Engineering Support Center, Huntsville (USAESCH), Contract No. W912DY-04-D-0019, Task Order No. 006. All field activities conducted during this RI were in accordance with the RI Work Plan (UXB, 2011).

1.0.2 The purpose of this RI was to collect data necessary to determine the nature and extent of potential munitions and explosives of concern (MEC), munitions debris (MD), and munitions constituents (MCs) resulting from historical military activities conducted within the AOI. In order to develop the conceptual site model (CSM) for the AOI, the RI Report includes data collected during the current investigation and results from previous investigations. The data presented is used to support fate and transport analysis, evaluate the potential risks to human health and the environment, and will be used to support the development of a Feasibility Study (FS) to evaluate future response actions at the AOI, if necessary. This RI Report documents the methods and procedures employed during field activities, and presents the results of the AOI site characterization.

1.0.3 Between 1944 and 1947, the AOI was used for day and night practice bombing activities using water-filled bombs, miniature bombs, and flares. Practice bombs were used with signals (also called spotting charges) that would permit pilots to observe bombing accuracy. The signals contained expelling charges and marker charges composed of pyrotechnic mixtures. Upon impact with water or land, the signal would detonate, producing a flash and a large puff of smoke. Since the end of military operations in 1947, practice bombs, primarily consisting of the AN-Mark (MK) 23 containing spotting charges have been identified at the AOI by the public. The practice bombs that remain at the AOI present a potential explosive safety hazard.

1.0.4 To achieve the goals established for this RI, various field investigative activities were conducted including: geophysical surveying, intrusive investigations, and environmental sampling for analysis of MCs. To facilitate the RI, the AOI was subdivided into four sub-area types according to sub-area geomorphology, which included land, beach, inland water, and ocean areas. The investigations were designed such that the type of geophysical methods and instrumentation proposed were appropriately matched to the unique character of each sub-area.

1.0.5 A wide area assessment was initially performed to help identify high density areas of geophysical anomalies that might be indicative of an area previously used as a military target, aid in determining the extent of potential MEC contamination, and focus subsequent detailed intrusive investigations. The wide area assessment consisted of:

- Analog density transects in the upland areas using hand-held analog instruments to minimize the amount of brush clearing;
- Digital Geophysical Mapping (DGM) transects on the beach area where no vegetation clearing was required;
- Underwater DGM in the inland water areas; and,
- Analog mag/dig ocean transects.

1.0.6 This work was supplemented with an airborne magnetometry (AirMag) survey performed using a magnometer array mounted to a helicopter. The AirMag was flown over portions of the land, beach, and shallow inland water/surf zone at 3 to 10 feet (ft) above the surface.

1.0.7 Data collected during the wide area assessment was subsequently used to site grids for additional DGM surveying and intrusive investigation within inland water, land, and beach areas. Based upon the results of the wide area assessment, anomalies were identified, mapped using ESRI ArcGIS, and analyzed to identify high-density anomaly areas. The grids were sited in areas of high, medium, and low anomaly densities to refine the extent, and establish the nature of MEC contamination through subsequent intrusive investigations. High-density anomaly areas were then used to determine the size and location of grids over which additional DGM data would be collected. Thirty-eight land DGM and 11 inland DGM water grids were located within the AOI. Geophysical data were collected in the grids by towing the electromagnetic (EM) sensor system by hand (land grids) or by boat (inland water grids) across the surface. DGM data collected within the grids were evaluated and a list of anomalies to be intrusively investigated was generated.

1.0.8 The intrusive investigation was conducted by reacquiring the anomaly locations selected for intrusive investigation and excavating the locations to identify the source of the anomaly. Excavation of land/beach locations were conducted by unexploded ordnance (UXO) technicians and excavation of inland water locations were conducted by UXO divers. Once identified, debris was classified as non-MD, cultural artifacts, MD, or MEC. During the intrusive investigation, 88 MEC items and 325 MD items were recovered. Recovered items included intact and expended AN-MK23 3-pound practice bombs and the remnants of a 100-pound practice bomb. Recovered MEC and MD items were concentrated on Little Neck around the historic bomb target location. MD and MEC items discovered during the intrusive investigation were removed, demilitarized, and properly disposed.

1.0.9 Due to the dynamic nature of the ocean surf zone, a “Mag and Dig” technique was used for ocean transects. Divers identified anomalies on transects using an underwater hand-held analog instrument, and subsequently excavated each anomaly as it was found. This methodology provided both wide area assessment and intrusive investigation to provide nature and extent data. No MD or MEC items were identified during intrusive investigations performed in ocean areas.

1.0.10 Between 13 October and 2 November 2011, environmental sampling for MCs was conducted at the AOI. Sampling included incremental and discrete, biased soil samples as well as sediment and groundwater samples. Based upon the composition of the munitions items identified within the AOI, samples were collected and sent to an off-site laboratory for analysis of antimony, copper, lead, nickel, and zinc and explosive compounds, including pentacrythrite tetranitrate (PETN) and nitroglycerin (NG). Analytical results indicated that antimony, lead, and zinc were detected in various samples at concentrations that exceed their respective ecological screening criterion in soil, but below the human health screening criterion. All other detections of metals in soil, sediment, and groundwater were below applicable screening criterion. No explosives were detected in any samples collected within the AOI.

1.0.11 Using the data obtained through this RI and information collected during previous investigations and removal actions, a qualitative MEC Hazard Assessment (HA) was conducted for the AOI. Under current conditions, the AOI received a hazard level category of 2 indicating high potential explosive hazard conditions are present at the AOI.

1.0.12 A Munitions Response Site Prioritization Protocol (MRSPP) ranking will be calculated to assign a relative priority for the AOI in the MMRP Inventory to determine the future funding sequence of MRSs for response activities. This ranking system uses scores of 1 through 8, 1 indicating the highest potential hazard and 8 indicating the lowest potential hazard, to determine a relative priority for response activities. The MRSPP worksheets and score will be submitted as a stand-alone submittal.

1.0.13 A Human Health Risk Assessment (HHRA) was conducted for the AOI to provide a comprehensive assessment of potential risks to individuals that may be exposed to hazardous constituents at the AOI. Because no chemicals of potential concern (COPCs) have been identified in AOI media, only an exposure analysis was conducted. The HHRA concluded that there is no unacceptable risk to human health from MC at the AOI.

1.0.14 A Screening-level Ecological Risk Assessment (SLERA) was performed as part of the RI to evaluate risks posed to ecological receptors (plants, invertebrates, herbivores, predators, and marine receptors) due to exposures to residual MCs. This assessment evaluated potential risk by 1) comparing analytical results to the applicable ecological screening criterion, 2) comparing constituent concentrations that exceeded ecological screening criteria with the 50th percentile background values and 95 percent upper confidence Limit (UCL), and 3) based on site data, refined the ecological screening level for lead using less conservative exposure assumptions. Based upon the results of the SLERA, none of the MCs evaluated pose a potential for risk to ecological receptors.

1.0.15 Based upon the RI results, it is recommended that the Little Neck Bomb Target Munitions Response Area (MRA) be subdivided into three Munitions Response Sites (MRSs), comprising the land target area (62 acres), the inland water area (172 acres) and the remaining land MRS (15 acres). In addition, the information gathered from historical records, previous investigations, and RI results, a FS is recommended to evaluate future response action alternatives with regard to MEC hazards at the Little Neck Bomb Target MRA.

2.0 INTRODUCTION

2.0.1 This RI Report was prepared by UXB on behalf of the CENAE for the Former Cape Poge Little Neck Bomb Target AOI, which will be referred to hereinafter as the AOI. Although the FUDS boundary for the Former Cape Poge Little Neck Bomb Target (D01MA0595ZZR01) consists of 141 acres covering the historic target location, the AOI was expanded to encompass the current boundaries to include areas where MEC and MD items have been identified during previous investigations and by the public. The FUDS boundary for the Former Cape Cope Little Neck Bomb Target (D01MA0595ZZR01) included two parcels of land totaling approximately 141 acres: Little Neck Bomb Target (82.89 acres) and Cape Poge Beach Calibration Range (58.5 acres). Based upon its historic use (training of glide path angles), the fact that no munitions were used at the site, and the MRSPP score developed during the Preliminary Assessment (PA) indicated that no known or suspected hazards were present (USACE, 2009); the Cape Poge Calibration Range is not included in this RI.

2.0.2 Although the FUDS boundary for the Little Neck Bomb Target consisted of 82.89 acres, the AOI was expanded to encompass the current boundaries (approximately 800 acres) to include areas where MEC and MD items were identified during previous investigations and by the public. MEC and MD items have been reported by the public since World War II training activities began at Little Neck including one incident of a AN-MK23 practice bomb hitting a residence west of the bomb target (USACE, 2009), and many fisherman and local residents finding practice bombs in Cape Poge Bay.

2.0.3 UXB has prepared this document under contract to the USAESCH, Contract No. W912DY-04-D-0019, Task Order No. 006. This report was prepared in accordance with Engineering Manual 1110-1-1200 (USACE, 2003) Interim Guidance 06-04, and Draft Engineering Pamphlet 1110-1-18 (USACE, 2006). All field activities were conducted in accordance with the Comprehensive Environment Response, Compensation, and Liability Act (CERCLA) 1980, as amended by Superfund Amendments and Reauthorization Act of 1986; the National Contingency Plan; and the RI Work Plan (UXB, 2011).

2.1 Purpose

2.1.1 The purpose of this RI Report is to document the methods employed during field activities and present the results of the AOI site characterization. The RI was conducted to collect data necessary to:

- Determine the nature and extent of MEC, MD, and MCs;
- Support MC fate and transport analysis;
- Evaluate the potential risks to human health and the environment;

- Develop a MRSPP score, and;
- Support the development of a FS to evaluate future response actions, if necessary.

2.2 Property Description and Problem Identification

2.2.1 The following subsections describe potential safety hazards associated with the AOI, describe the physical characteristics of the site, and identify potential receptors.

2.2.1 Explosives Safety Hazards

2.2.1.1 The Former Cape Poge Little Neck Bomb Target was used during World War II for day and night practice bombing activities using water-filled bombs, miniature bombs, and flares. The types of munitions potentially used at the bomb target include:

- 100-pound practice bombs, MK15-series;
- Miniature practice bombs, AN-MK5 Mod 1, AN-MK23, AN-MK43;
- Signal, practice bombs, MK4 Mods 3 & 4;
- Signal, practice bombs, MK6 Mod 0; and,
- Flare, aircraft, parachute, M26 & AN-M26 (USACE, 2009b).

2.2.1.2 Practice bombs were used with signals (also called spotting charges) that would permit pilots to observe bombing accuracy. The signals contained expelling charges and marker charges composed of pyrotechnic mixtures. Upon impact with water or land, the signal would detonate, producing a flash and a large puff of smoke.

2.2.1.3 Since the end of military operations in 1947, practice bombs, primarily consisting of the AN-MK23 containing spotting charges of black powder and red phosphorus, have been identified at the AOI by the public. If spotting charges are discharged, they may cause serious injury. Therefore, practice bombs that remain at the AOI present a potential explosive safety hazard.

2.2.2 Physical Characteristics

2.2.2.1 Site Description

2.2.2.1.1 As shown on Figure 2-1, the AOI is located on Chappaquiddick Island, which is within the Town of Edgartown, Martha's Vineyard, Massachusetts. The site encompasses an area of approximately 800 acres (Figure 2-2). These 800 acres are divided into approximately 153 acres of land, 83 acres of beach, 500 acres of inland water, and 64 acres of ocean (UXB, 2011).

2.2.2.1.2 The historic bomb target was located on the western portion of Little Neck peninsula (Figure 2-2). Currently, there are no buildings or other structures located on the Little Neck peninsula. However, during military use, a bombing target was constructed at Little Neck.

Available records do not specify the precise layout of the target, but the U.S. Navy developed a diagram illustrating the standard target, which is shown on Figure 2-3. The standard target consisted of a 6.5-ft by 6.5-ft pyramid set up at the target center with a 100 ft circular landing zone from the target center. In addition, a 1,500 ft safety zone was established around the target to protect watercraft and aircraft. The total target area encompassed approximately 162 acres (USACE, 2009b).

2.2.2.2 Current and Future Land Use

2.2.2.2.1 Currently, the AOI is primarily owned by The Trustees of Reservations (TTOR), the Commonwealth of Massachusetts (inland and coastal waters), and private landowners. A portion of the AOI is part of the Cape Poge Wildlife Refuge. Figure 2-4 illustrates which property tracks are owned by public entities and which tracts are privately owned within the AOI. The site remains mostly undeveloped with several residential properties scattered throughout Cape Poge, north of Shear Pen Pond. Common property activities include, but are not limited to, sunbathing, swimming, four-wheel driving, picnicking, hiking, commercial and recreational fishing, clamming, scalloping, crabbing, and visiting the lighthouse. It is anticipated that the future land use will remain the same (USACE, 2009b).

2.2.2.3 Topography

2.2.2.3.1 The topography of the AOI can generally be described as relatively flat with elevations ranging from 0 to approximately 24 ft above msl (Figure 2-5). Interdunal swales are found in small depressions in the upland areas. The swales are ephemeral and form when winds scour sand until the water table is reached (USACE, 2009).

2.2.2.4 Habitat and Vegetation

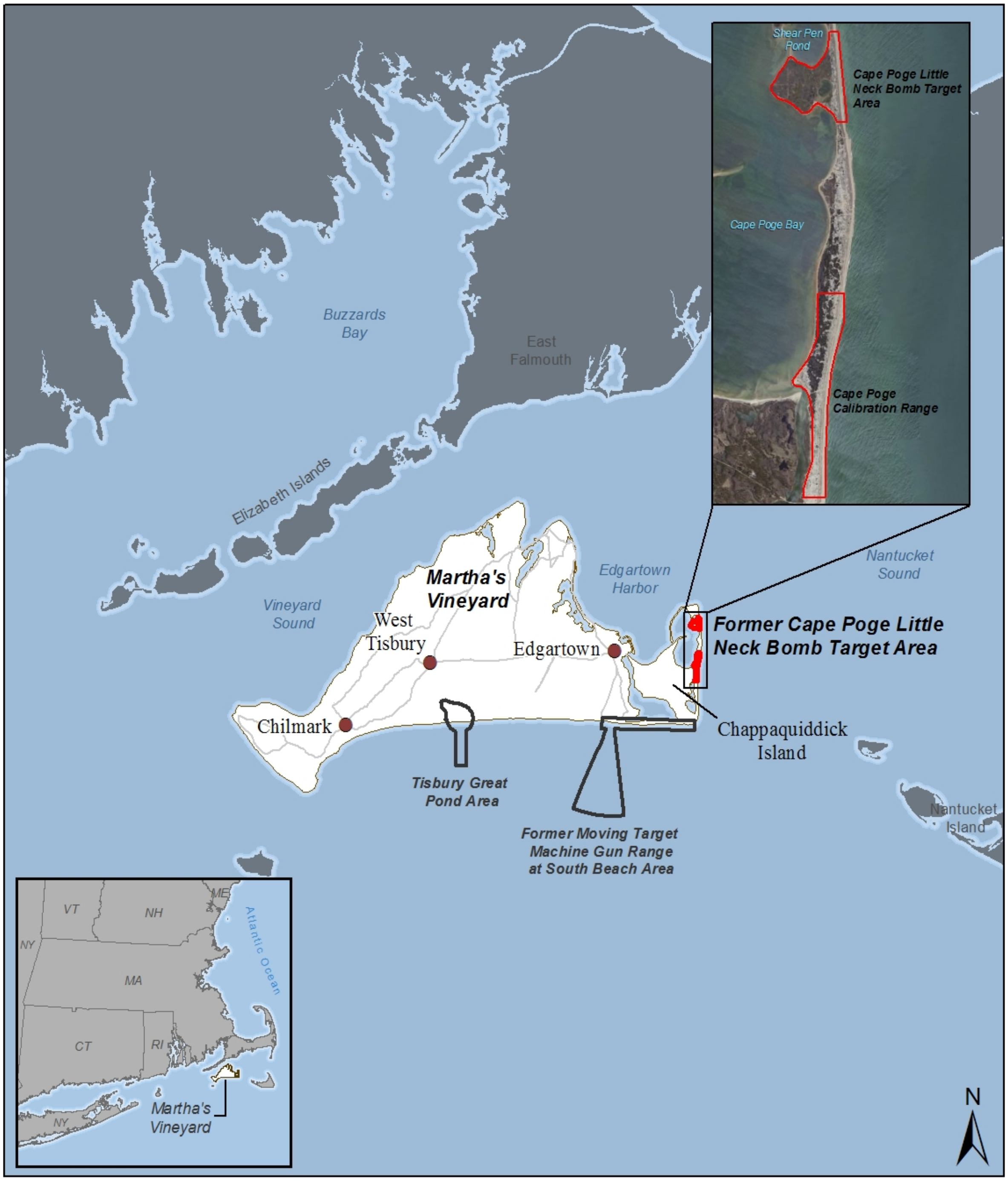
2.2.2.4.1 The current AOI includes four habitat types: 1) upland habitat; 2) inland water; 3) beach; and 4) ocean (Figure 2-2). These areas provide habitat to a variety of plants, invertebrates, herbivores, predators, and marine receptors. On 17 March 2011, a botanist conducted a sensitive plant survey of the upland target area of Little Neck prior to its sampling (AMEC, 2011). The lowest, intertidal estuarine areas were found to be dominated by salt-meadow cordgrass (*Spartina patens*), salt-marsh cordgrass (*S. alterniflora*), salt grass (*Distichlis spicata*), and glasswort (*Salicornia* sp.). Above these areas was an estuarine, broad-leaved deciduous scrub/shrub vegetation dominated by groundsel-bush (*Baccharis halimifolia*), which was found in dense thickets throughout Little Neck. Also present in the vegetation were northern bayberry (*Myrica pennsylvanica*), poison sumac (*Toxicodendron vernix*), Virginia rose (*Rosa virginiana*), grape (*Vitis* sp.), and Oriental bittersweet (*Celastrus orbiculata*). Big-leaf sumpweed (*Iva frutescens*) formed a fringe around these estuarine wetlands. Above these areas (in the driest parts of Little Neck upland habitat), eastern red cedar (*Juniperus virginiana*) was the most common species, with a few individuals of scrub oak (*Quercus ilicifolia*) along with Virginia creeper (*Parthenocissus quinquefolia*) common yarrow (*Achillea millefolium*), and switch grass (*Panicum virgatum*).

2.2.2.4.2 The AOI contains significant ecological resources and is potential habitat for threatened, endangered, or other sensitive or protected species. The AOI is mapped as “Core Habitat” and "Critical Natural Landscape" by the Massachusetts Natural Heritage Endangered Species Program (MA NHESP) BioMap2 town report for Edgartown (MA NHESP, 2012). Core habitat identifies areas that are critical to long-term persistence of rare species in Massachusetts. Critical Natural Landscape encompasses habitat used by wide ranging species (e.g. tern), large areas of contiguous habitat, and buffer habitat. The Investigation Area is within Core Habitat area 102 and Critical Natural Landscape area 45.

2.2.2.5 Climate

2.2.2.5.1 Martha’s Vineyard has a temperate marine climate. Although Martha’s Vineyard’s weather is typically moderate, there are occasions where the island experiences extreme weather conditions such as blizzards and hurricanes. Martha’s Vineyard's generally experiences a delayed spring season, being surrounded by an ocean that is still cold from the winter; however, it is also known for an exceptionally mild fall season, due to the ocean remaining warm from the summer. The highest temperature ever recorded on Martha’s Vineyard was 99 degrees Fahrenheit (°F) in 1948, and the lowest temperature ever was -9°F in 1961 (USACE, 2009b).

2.2.2.5.2 Precipitation on Martha’s Vineyard and the islands of Cape Cod and Nantucket is the lowest in the New England region, averaging slightly less than 40 inches (in.) per year. This is due to storm systems that move across western areas, building up in mountainous regions, and dissipating before reaching the coast (USACE, 2009b).



US Army Corps of Engineers

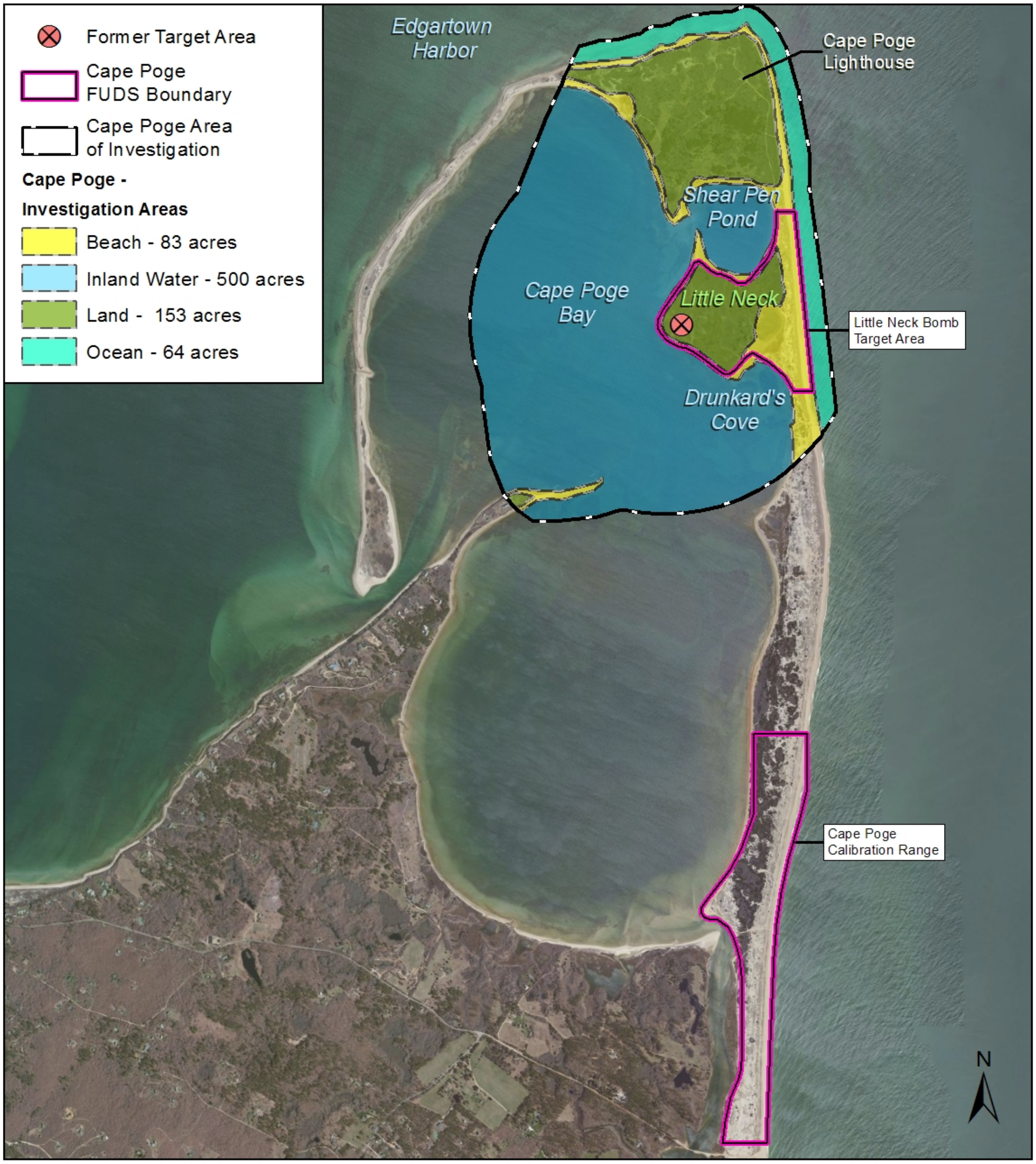
FIGURE 2-1
Site Location - Martha's Vineyard, MA

0 2.5 5 10 15 Miles
0 5 10 15 20 25 Kilometers

UXB amec

NOTES:
Base map data source: ESRI

05/04/2012	Rev: 07/24/2012	CPoge_MV_Island_Remedial_Inv_Rpt.mxd
Drawn: JBO	Chk: DMS	PROJ: 562910000



US Army Corps of Engineers

FIGURE 2-2

Site Map - Former Cape Poge Little Neck Bomb Target Area of Investigation, Martha's Vineyard, MA

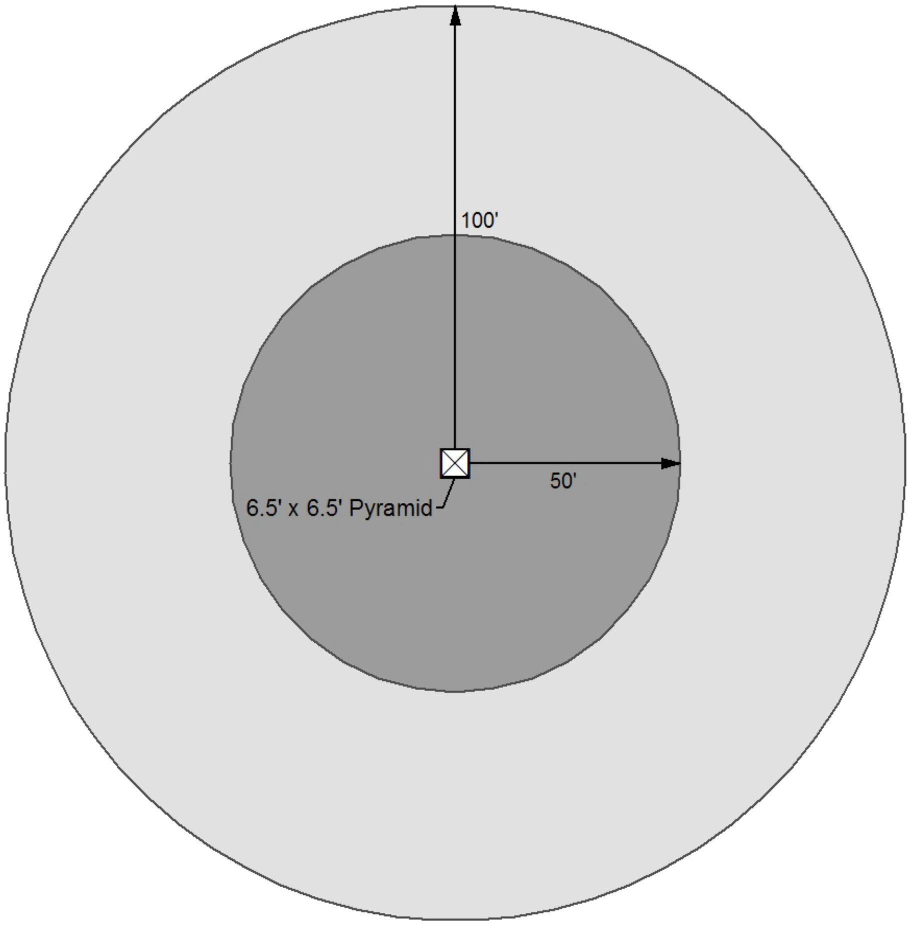
0 200 400 800 1,200 1,600 Meters

0 1,000 2,000 4,000 6,000 Feet

UXB amec

NOTES:
2011 Aerial Data Source: Bing Maps, Microsoft Corp.

04/12/2012	Rev: 07/24/2012	CPoge_Site_Loc_ Remedial_Inv_Rpt.mxd
Drawn: JBO	Chk: DMS	PROJ: 562910000



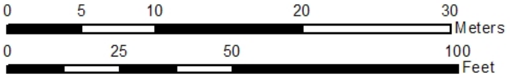
CLEARANCE: 1500' radius, minimum. safety restrictions on land surface areas. 2 mile radius air and water traffic danger or caution area established, as required. Notice to Mariners and Airmen made on appropriate charts.

SECURITY: Warning Signs (P.IT.Dwg.#S-288). 1500' minimum distance from target, spaced 300' apart; closer spacing as required by visibility limitations. Fencing and firebreaks not required. Where 1500' safety clearance overlaps water areas, use larger Warning Signs to warn off surface craft.

MISSILES: miniature 2.5# and 100# waterfillable bombs, only 500# and 1000# waterfillable bombs may be used on specific, isolated target sites.

US Army Corps of Engineers

FIGURE 2-3
Typical Land Dive and Glide Bombing Target
(Adapted from 1947 Drawing)



UXB amec

NOTES:
Adapted from Naval Air Station, Quonset Point, R.I. Public Works Dept. drawing # S-1310, March 10, 1947

05/04/2012	Rev:	CPoge_Site_Loc_ Remedial_Inv_Rpt.mxd
Drawn: JBO	Chk: DMS	PROJ: 562910000

US Army Corps of Engineers

FIGURE 2-4
Current Land Use - Former Cape Poge Little Neck Bomb Target
Area of Investigation, Martha's Vineyard, MA

0 100 200 400 600 800 Meters
0 500 1,000 2,000 3,000 Feet

UXB
amec

NOTES:
2011 Aerial Data Source: Bing Maps, Microsoft Corp.

05/02/2012
Rev: 07/24/2012
CPoge_Privt_Pub_Land_Remedial_Inv_Rpt.mxd
Drawn: JBO
Chk: DMS
PROJ: 562910000

US Army Corps of Engineers

FIGURE 2-5

Topographic Map - Former Cape Poge Little Neck Bomb Target Area of Investigation, Martha's Vineyard, MA

0 0.5 1 1.5 Kilometers
0 0.5 1 Miles

UXB amec

NOTES:
2011 Aerial Data Source: Bing Maps, Microsoft Corp.

05/04/2012 Rev:
CPoge_Site_Loc_Remedial_Inv_Rpt.mxd
Drawn: JBO Chk: DMS PROJ: 562910000

2.2.2.6 Soils

2.2.2.6.1 The soils within the AOI include the upland soils, Udipsamments and Carver loamy coarse sand, and the marsh area soils, Pawcatuck and Matunuck mucky peats. The upland soils are found on sand dunes, outwash plains, and terminal moraines. These soils are coarse textured, very deep, and excessively drained. These soils have rapid to very rapid permeability and depth to seasonal high water tables are greater than 6 ft. The marsh area soils are very deep, poorly drained soils in tidal areas subject to daily inundation. These soils are typically adjacent to shore areas and brackish ponds and have a surface layer that is approximately 2 ft thick consisting of an organic peat. Under the organic layer is a substratum consisting of coarse sand that is greater than 5 ft thick. The permeability of these soils is moderate to rapid in the organic material and very rapid in the substratum. The daily tidal flooding limits these soils for most uses other than wetlands (United States Department of Agriculture – Soil Conservation Service [USDA-SCS], 1986).

2.2.2.7 Geology

2.2.2.7.1 The AOI and the island of Martha’s Vineyard are relics of the last ice age and the warming trends that followed. Repeated glaciations scraped soil and rock from the mainland of New England. Eighteen-thousand years ago, the glaciers reached their southernmost extent and began to melt and retreat, depositing the rock and soil, once trapped within the ice, as terminal moraines. These terminal moraines can be found on Martha’s Vineyard (USACE, 2009b).

2.2.2.7.2 The geological deposits that make up the site consist of recent beach and marsh sediments, glacial deposits, interglacial deposits, and glacially deformed ancient coastal plain sediments. The county consists mostly of deposits from the last glacial stage, but in places consists of glacial or interglacial deposits as much as 300,000 years old (USACE, 2009b). These deposits overlie solid bedrock and range from approximately 500 ft thick on the north shore of Martha’s Vineyard to 900 ft thick on the south shore (USACE, 1999). The bedrock consists of metamorphic rocks, such as schist and gneiss, and igneous rocks (USACE, 2008a; USACE, 2009b).

2.2.2.8 Surface Water Hydrology

2.2.2.8.1 Soils in the upland areas and on the beaches are excessively drained and have very high permeability (USDA-SCS, 1986). Due to these properties, there is very little to no surface water runoff in these areas. In low-lying areas, such as marshes, the soils are poorly drained and inundated due to tidal changes on a daily basis (USDA-SCS, 1986). Surface water in these areas drains into larger bodies of water, such as Shear Pen Pond, Cape Poge Bay, and the Atlantic Ocean.

2.2.2.9 Groundwater Hydrology

2.2.2.9.1 The principal aquifers on Martha’s Vineyard are moraines and outwash deposits, which derive their water from local precipitation. Bedrock is much less permeable than the overlying sediments, commonly contains seawater, and is not considered part of the aquifers of Martha’s Vineyard (USACE, 2009b).

2.2.2.9.2 On Cape Poge, the water table generally mimics topography and is influenced by tidal fluctuations. Groundwater quality studies indicate that salt-water intrusion occurs along the coastline and to a lesser degree throughout the interior of the island. Depth to groundwater ranges from greater than 6 ft below ground surface (bgs) in upland soils to near ground surface in lower areas near shorelines and marshes (USACE, 2009b). The shallow freshwater aquifer is underlain by brackish water that is unsuitable for human consumption (USACE, 2008a). There is no freshwater underlying the historic target area at Little Neck.

2.2.3 Potential Human and Ecological Receptors

2.2.3.1 Demographics

2.2.3.1.1 The AOI is located on Chappaquiddick Island, which is within the Town of Edgartown, Martha’s Vineyard, Massachusetts. According to the 2010 Census, census track 2003 (approximately 27 square mile area) has a population of 4,067 and contains 5,220 total housing units, of which 1,794 houses are occupied by year-round residents, 3,258 are seasonal or occasional use, and the remaining 168 houses are unoccupied. Due to seasonal occupancy, the population within the census tract may significantly increase. According to the Martha’s Vineyard Chamber of Commerce, the population of Martha’s Vineyard increases from 16,535 in non-summer months to more than 125,000 in the summer months (Martha’s Vineyard Chamber of Commerce, 2012).

2.2.3.2 Potential Receptors

2.2.3.2.1 Based on the historical use and physical characteristics of the AOI, potential media of concern include surface soil, subsurface soil, sediment, and groundwater. Potential receptors include residents, visitors/trespassers, site workers, and biota (mammals, fish, soil invertebrates, shellfish, birds, reptiles, insects, and plants). A detailed discussion of potential human and ecological receptors is discussed in Sections 7.3 and 7.4, respectively.

2.2.3.2.2 Because access to the AOI is not restricted, potentially impacted soils and sediments could present a risk to residents, visitors/trespassers, and biota via direct contact, accidental ingestion, and ingestion of plants that uptake constituents from the soil/sediment. Potentially impacted surface water could present a risk to residents, visitors/trespassers, and biota via direct contact and accidental ingestion. Potentially impacted groundwater could present a risk to residents, site workers, and biota via direct contact and ingestion.

2.2.3.3 Threatened, Endangered, or Special Concern Species

2.2.3.3.1 The AOI has been designated as a Priority Habitat of Rare Species and Estimated Habitats of Rare Wildlife in the Massachussetts Natural Heritage Atlas 13th Edition (effective October 1, 2008). Habitat alteration within areas mapped as Priority Habitats (PH) may result in a take of a state-listed species, and is subject to regulatory review by the Natural Heritage & Endangered Species Program. Priority habitat maps are based on known occurrence of rare species and habitat considerations. The AOI is mapped as PH 15. Based upon coordination with the U.S. Fish and Wildlife Service, National Marine Fisheries Service, and Massachusetts Natural Heritage and Endangered Species Program; there are approximately 37 federal/state threatened, endangered, and/or special concern species that have been observed on Martha’s Vineyard (Table 2-1). Table 2-2 summarizes the observed species found within the AOI. These include piping plover (Charadrius melodus) a federally threatened species which utilizes beach and nearby upland habitat, and the federally endangered roseate tern (Sterna dougallii) and four federally listed sea turtle species which utilize nearshore ocean habitat.   Sea turtles occur seasonally off the coast of Martha's Vineyard from June through early November of any year. While they may occur near shore off of Cape Poge, they are likely to occur in the offshore MRS only briefly as transients. State listed species include many insect and plant species which utilize upland coastal sandplain or beach habitat.

2.2.3.4 Observations During RI Fieldwork

2.2.3.4.1 The RI field work schedule was developed specifically to avoid nesting seasons/fledgling seasons (spring/summer) as much as possible. From April 4 to April 20, 2011, TTOR staff provided monitoring on the TTOR Reservation to ensure the RI work was not interfering or encroaching on the protected bird species. No piping plovers or other threatened or endangered species were observed during the time work was conducted in the investigation area.

Table 2-1. Endangered, Threatened, and Special Concern Species Former Cape Poge Little Neck Bomb Target Area of Investigation

Common Name	Scientific Name	State Status	Federal Status
Birds			
Common Tern	*Sterna hirundo*	Special Concern	--
Roseate Tern	*Sterna dougallii*	Endangered	Endangered
Least Tern	*Sterna antillarum*	Special Concern	--
Northern Harrier	*Circus syneus*	Threatened	--
Piping Plover	*Charadrius melodus*	Threatened	Threatened
Reptiles			
Green Sea Turtle	*Chelonia mydas*	Threatened	Threatened
Leatherback Sea Turtle	*Dermochelys coriacea*	Endangered	Endangered
Loggerhead Sea Turtle	*Caretta caretta*	Threatened	Threatened
Kemp's ridley Sea Turtle	*Lepidochelys kempi*	Endangered	Endangered
Insects			
Northeastern beach tiger beetle	*Cicindela dorsalis dorsalis*	Endangered	Threatened
Chain dot Geometer	*Cingulia cateraria*	Special Concern	--
Coastal Heathland Cutworm	*Abagrotis nefascia*	Special Concern	--
Gerhard's Underwing Moth	*Catocala Herodias gerhardi*	Special Concern	--
Faded Grey Geometer	*Stenoporpia Polygrammaaria*	Threatened	--
Pine Barrens Zale	*Zale sp l nr lunifera*	Special Concern	--
Pink Sallow Moth	*Psectraglea carnosa*	Special Concern	--
Sandplain Euchaena	*Euchlaena madusaria*	Special Concern	--
Barrens Buckmoth	*Hemileuca maia*	Special Concern	--
Melsheimer's Sack Bearer	*Cicinus Melsheimeri*	Threatened	--
Pine Barrens Lycia	*Lycia ypsilon*	Threatened	--
Coastal Swamp Metarranthis Moth	*Metarranthis pilosaria*	Special Concern	--
Slender Clearwig Sphinx Moth	*Henaris pilosaria*	Special Concern	--
Spartina Borer Moth	*Spartiniphagia inops*	Special Concern	--
Imperial Moth	*Eacles imperialis*	Threatened	--
Barrens Metarranthis Moth	*Metarranthis apiciaria*	Endangered	--

Table 2-1. Endangered, Threatened, and Special Concern Species (continued)
Former Cape Poge Little Neck Bomb Target Area of Investigation

Common Name	Scientific Name	State Status	Federal Status
Comet Darner	*Anax longippes*	Special Concern	--
Purple Tiger Beetle	*Cicindela purpurea*	Endangered	--
Three-Lined Angle Moth	*Digrammia eremiata*	Threatened	--
Plants			
Sandplain gerardia	*Agalinus acuta*	Endangered	Endangered
Bristly Foxtail	*Setaria parviflora*	Special Concern	--
Bushy Rockrose	*Crocanthemum dumosum*	Special Concern	--
Purple Needlegrass	*Aristida purpurascens*	Threatened	--
Sandplain Flax	*Linum intercursum*	Special Concern	--
Saltpond Pennywort	*Hydrocotyle verticellata*	Threatened	--
Pygmyweed	*Tillacea aquatica*	Threatened	--
Sandplain Blue-eyed grass	*Sisinchium fuseatum*	Special Concern	--
Nantucket Shadbush	*Amelanchier nantuckensis*	Special Concern	--
Sea-Breach Knotweed	*Polygonum glaucum*	Special Concern	--

Note:
This list was obtained from the RI Work Plan (UXB, 2011).
-- Stuts not listed

Table 2-2. Observed Species within Former Cape Poge Little Neck Bomb Target Area of Investigation

Species	Federal Threatened and Endangered Species?	Massachusetts Threatened and Endangered Species?	Found Within FUDS MRS?	Found On Martha's Vineyard?	Comment	Reference
Piping plover (Charadrius melodus)	Yes	Yes	Yes	Yes	During the 2009 breeding season, 7 pairs of piping plover bred on Cape Poge Refuge	Final TCRA After Action Report (March 2010)
Roseate Tern (Sterna dougallii)	Yes	Yes	Yes	Yes	15 pairs nested along the southern shore of Shear Pen Pond in 1982. The colony was flooded out and the site occupied by nesting gulls in 1984.	Email Chris Buelow, TTOR (27 Oct 2010)

2.3 Historical Information

2.3.1 Prior to the U.S. Navy acquiring leases for the Little Neck bomb target site, Chappaquiddick Island and Cape Poge were used for agricultural purposes and as a summer resort. By March 1944, The U.S. Navy had identified Little Neck as a potential bombing target location. Between 26 June and 4 July 1944, the U.S. Navy constructed a target at the site. By 28 February 1945, the Navy had formally executed the leases for all of the properties at Little Neck with a retroactive start date of 1 July 1944 (USACE, 2009b). The leases were acquired for the purpose of a bombing target for the 1st Naval District Flight Training Program at Naval Air Station Quonset Point, Rhode Island, and the Naval Auxiliary Air Station, Martha's Vineyard, Massachusetts. The 1st Naval District used the site for approximately 2 years before the Chief of Naval Operations approved the discontinuance of the Little Neck target on 15 March 1947 (USACE, 2009b).

2.3.2 The First Naval District referenced the site as: L-5-V Little Neck (USACE, 2009b). In February 1945, operations began at the L-5-V Little Neck Site. The site was used for day and night practice bombing activities using water filled bombs, miniature bombs, and flares. The types of munitions potentially used at the bomb target include:

- 100-pound practice bombs, MK15-series;
- Miniature practice bombs, AN-MK5 Mod 1, AN-MK23, AN-MK43;
- Signal practice bombs, MK4 Mods 3 & 4;
- Signal practice bombs, MK6 Mod 0; and,
- Flare, aircraft, parachute, M26 & AN-M26 (USACE, 2009b).

2.3.3 On 26 August 1946, bombing activities at L-5-V Little Neck were suspended due to citizen complaints. Although the site remained active, it is not clear whether bombing activities ever resumed before the U.S. Navy approved the discontinuance of the site on 15 March 1947. The leases were terminated on 18 May 1947. Records do not indicate that the property was ever used to store, transport, treat, or dispose of the associated munitions used on property. By 1959, most of Cape Poge had been donated to The Trustees of Reservations by Charles S. Bird and Oliver D. Filley (USACE, 2009b).

2.4 Previous Investigations

2.4.0.1 Investigations conducted prior to the 2011 RI at the AOI include:

- Inventory Project Report (INPR), CENAE, 2008;
- Visual Ordnance Sweep, VRHabilis, LLC (VRH), 2008;
- Preliminary Assessment (PA), USACE St. Louis District, 2009;

- Time Critical Removal Action (TCRA), EOD Technology, Inc., 2009; and
- Emergency Response, VRH, 2010.

2.4.0.2 The following subsections detail the findings of each of these investigations.

2.4.1 Inventory Project Report

2.4.1.1 In July 2008, the CENAE prepared an INPR in support of the Defense Environmental Restoration Program FUDS. The Findings and Determination of Eligibility for the AOI established the eligibility of 141 acres as a FUDS. An MMRP project was proposed and the INPR identified a MEC category hazard potential. The INPR assigned a MRSPP priority ranking of 5 (USACE, 2009b).

2.4.2 Visual Ordnance Sweep

2.4.2.1 On 6 November 2008, VRH, under contract with MA DEP, conducted a visual ordnance sweep at Little Neck with assistance from TTOR. The visual sweep was conducted to:

- Identify immediate public safety hazards;
- Identify and remove non-hazardous ordnance items or related items (fragmentation, AN-MK23 bodies, etc.) and place the items in secure storage; and
- Identify and remove any non-ordnance items which could be construed as an ordnance item resulting in a response by TTOR, VRH, or law enforcement personnel (VRH, 2008).

2.4.2.2 The visual sweep was conducted on the interior beach beginning at Drunkard's Cove, around Little Neck toward Shear Pen Pond, and then around Shear Pen Pond ending at the beginning of privately owned property. The sweep covered approximately 15,300 linear ft of beach, which was approximately 31 ft wide. A Schonstadt metal detection device was used to augment the visual search, clear flooded blast holes, and help qualify unknown items. The visual sweep resulted in the identification, removal, and storage of 15 AN-MK23 fragments, which were safe to move and did not require demilitarization. Additionally, nine ferrous metal items (aluminum pieces, lobster pot pieces, aluminum tubing, etc.) were identified, removed, and disposed (VRH, 2008). The Visual Ordnance Sweep Report is included in Appendix A.

2.4.3 Preliminary Assessment

2.4.3.1 In February 2009, the USACE, St. Louis District prepared a Draft PA for the Former Cape Poge Little Neck Bomb Target Site. This report was prepared in coordination with the CENAE and the USAESCH. The PA was compiled through research and analysis of historical text, maps, and photographs at various archives and records holding facilities. Additionally, property visits and interviews were conducted to collect information concerning the subject property. Research efforts were directed toward determining the presence of hazardous substances as a result of historical activities performed by the U.S. Navy. This assessment was performed to obtain information for use in developing recommendations for further action at the subject property (USACE, 2009b).

2.4.3.2 The PA determined that the U.S. Navy utilized practice ordnance at the bomb target. The historical activities at the site included the use of 100-pound water-filled practice bombs with spotting charges, practice miniature bombs with spotting charges, and flares. Visual observations performed during the PA identified residual casings present in surface soil at the site and may be present in subsurface soil. Based on the presence of residual casings, it was determined that detectable levels of casing MCs (antimony, iron, lead, zinc) may be present in soil proximal to the casings. However, the MCs are not expected to result in adverse environmental effects in the aquatic environment. Although pyrotechnic signals were constructed in the practice bombs, these constituents are expected to have been released and no longer present in the environment at detectable levels (USACE, 2009b). No evidence was found to indicate that high explosive (demolition) bombs were used at the site.

2.4.3.3 Based on the findings of the PA, one MRS, L-5-V Little Neck Dive Bombing Target, was confirmed. A MRSPP score was developed for the MRS, which resulted in a ranking of 5 indicating a moderate risk for explosive hazards is present for the L-5-V Little Neck Dive Bombing Target Site (USACE, 2009b).

2.4.4 Time Critical Removal Action

2.4.4.1 Between 18 April and 25 September 2009, a TCRA was conducted at the Little Neck Dive Bombing Target Site (USACE, 2010). The TCRA was performed primarily to remove MEC, Material Potentially Presenting an Explosive Hazard (MPPEH), and explosive hazards at the site.

2.4.4.2 The removal action was conducted on approximately 46 acres within the AOI. To perform the identification and clearance operations, these 46 acres were subdivided into grids. Within each grid, 5-ft sweep lanes were established for conducting the magnetometer-assisted surface/subsurface/underwater clearance operations using a Schonstedt GA-52Cx magnetometer. All anomalies identified by the magnetometer were investigated and removed using hand tools and mechanical equipment. All MEC, regardless of size, as well as MPPEH, MD, non-MD, and range-related debris equal to or greater than an AN-MK23 practice bomb were removed and/or disposed. Figure 2-6 presents the locations of MD items that were identified and removed during the TCRA. During clearance operations, 127 MD items and 1,916 pounds of non-MD were removed. Items identified and removed included scrap items, AN-MK23, and AN-MK5 practice bombs. No MEC/MPPEH found at the site contained high explosive filler (USACE, 2010).

2.4.5 Emergency Response

2.4.5.1 Between 20 and 26 April 2010, VHR responded to two emergency calls associated with potential ordnance. The details of the emergency responses are presented in Table 2-3, and the emergency response reports are included in Appendix A.

Table 2-3. Emergency Responses
Former Cape Poge Little Neck Bomb Target Area of Investigation

Date	Location	Quantity	Ordnance Description	Response Action
21-04-2010	Little Neck	1	An AN-MK23 practice bomb was found under a caution sign at Little Neck. VRH determined that it was free of explosive hazard and was acceptable to move.	The practice bomb was secured in the container at Edgartown Police Headquarters.
26-04-2010	Little Neck	3	Three AN-MK23 pieces (two AN-MK23 bodies and one fragment) were located on the western edge of Little Neck. VRH determined that they were free of explosive hazard.	The AN-MK23 pieces were removed and secured in the container at Edgartown Police Headquarters.

Notes:
The information contained in this table was obtained from VHR Emergency Response Reports (VHR, 2010a and 2010b).
MK - Mark
VRH - VRHabilis, LLC

US Army Corps of Engineers

FIGURE 2-6

2009 TCRA Results - Former Cape Poge Little Neck Bomb Target Area of Investigation, Martha's Vineyard, MA

0 75 150 300 450 600 Meters
0 350 700 1,400 2,100 Feet

UXB amec

NOTES:
2011 Aerial Data Source: Bing Maps, Microsoft Corp.

05/04/2012	Rev:	CPoge_TCRA_Results_Remedial_Inv_Rpt.mxd
Drawn: JBO	Chk: DMS	PROJ: 562910000

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3.0 PROJECT REMEDIAL RESPONSE OBJECTIVES

3.0.1 This section discusses the results of the Technical Project Planning (TPP) Process, which is used to identify project objectives, assist in the data collection design, and to guide the project to ensure effective and efficient progress. During the TPP process, stakeholders provided input which resulted in the development of a CSM, preliminary remediation goals, the identification of potential applicable or relevant and appropriate requirements (ARARs) and "to be considered" (TBC) information, development for an Institutional Analysis, and determination of data needs and DQOs of the investigation, which are discussed below.

3.1 Conceptual Site Model and Project Approach

3.1.0.1 Evaluation of the site history, potential contaminant sources, environmental setting, and current and future land use have led to the development of a CSM, the major components of which have been summarized in Table 3-1. A discussion of the sources, release mechanisms, fate and transport processes as well as the pathway exposure analysis are discussed below.

3.1.1 Sources

MEC

3.1.1.1 Items containing explosives/pyrotechnics that were potentially used at the AOI included the spotting charges MK4 (used in the AN-MK5, AN-MK23, and AN-MK43 practice bombs) and MK7 (used in the MK15 practice bombs) and aircraft flares M26 and AN-M26. The MK4 spotting charge contained smokeless powder/red phosphorus, while the MK7 contained 1 pound of black powder. Aircraft flares were used to provide illumination and contained black powder and a pyrotechnics mixture to create the illuminating flare. Due to the construction of the pyrotechnic signals in the practice bombs (cardboard and thin metal), the pyrotechnic constituents are expected to have already been released and no longer present in the environment at detectable levels (USACE, 2009b). However, during the TPP Process, it was determined that explosives would be analyzed in all samples to identify the presence or absence of explosives constituents in environmental media.

MCs

3.1.1.2 MCs associated with ordnance potentially used at the AOI include metals used to construct the bomb casings and explosives utilized to make the spotting charges. Practice bombs identified during the 2009 TCRA consisted of AN-MK23 and AN-MK5 series bombs. The bomb casings of these bombs were comprised of cast iron (AN-MK23) and zinc alloy (AN-MK5). According to the PA, other bombs that may have been used at the site were

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Table 3-1. Evaluating Existing Data
Preliminary Conceptual Site Model Summary
Former Cape Poge Little Neck Bomb Target Area of Investigation

Facility Profile	Physical Profile	Release Profile	Land Use and Exposure Profile	Ecological Profile
Facility Description: • Approximately 800 acres. (1) • Located on the Little Neck peninsula, which is bound to the north by Shear Pen Pond, to the west and south by Cape Poge Bay, and to the east by a small strip of land that separates the AOI from the Atlantic Ocean. • No permanent structures were constructed by the U.S. Navy at the site. (2) • Available records do not specify the precise layout and usage the target; however, the standard range cell consisted of a circle with a radius of 1,500 feet (ft) from the target center and consisting of 162 acres. (2) **Site History:** • The site was used for day and night practice bombing activities from approximately July 1944 until approximately March 1947. (2) • Records do not indicate that the property was ever used to store, transport, treat, or dispose of the associated munitions used on property. (2) **Munitions Potentially Used:** • 100-Pound Practice Bombs, MK15-series; • Miniature Practice Bombs, AN-Mark (MK) 5 Mod 1, AN-MK 23, AN-MK43; • Signal Practice Bombs, MK4 Mods 3 & 4; • Signal Practice Bombs, MK6 Mod 0; and, • Flare, Aircraft, Parachute, M26 & AN-M26. (2)	**Site Characteristics:** • Approximately 153 acres of land • Approximately 83 acres of beach • Approximately 500 acres of inland water • Approximately 64 acres of ocean (1) **Topography:** • Relatively flat maritime shrub thicket, salt marsh, and maritime beach. (1) **Vegetation:** • Salt Marsh Cordgrass, Salt Meadow Cordgrass, Black Grass, Salt Marsh Fleabane, and glassworts, with Marsh Elder and Groundsel Tree along their fringes. (1) **Surface Water:** • Surface water is located within marshes and mudflats. • Surface water runoff is not expected in upland areas. **Soils:** • Soils located on the sand dunes consist of medium to coarse sands and are excessively drained. • Soils located in marshes consist of a dense layer of organic material over fine grained sand and are very poorly drained. **Geology:** • Glacial deposits consisting of recent beach and marsh sediments, glacial deposits, interglacial deposits, and glacially deformed ancient coastal plain sediments. (2) • Bedrock is encountered at approximately 500 ft below ground surface (bgs) and is comprised of metamorphic and igneous rocks. (2) **Hydrogeology:** • Depth of groundwater ranges from 0 to greater than 6 ft bgs. • Groundwater on Martha's Vineyard is primarily discharged directly to the ocean and surrounding bays. (2) **Meteorology:** • Average Annual Rainfall = 46 inches per year. (2)	**Contaminants of Potential Concern:** • Antimony, copper, lead, nickel, zinc, and explosives. • Munitions and explosives of concern (MEC) is a concern due to spotting charges within the practice bombs used at the Area of Investigation (AOI). **Media of Potential Concern:** • Surface soil, subsurface soil, sediment, and groundwater. **Confirmed Munitions Debris Locations:** • During the 2009 Time-Critical Removal Action, 127 Munitions Debris items were identified and removed. Items included AN-MK23 and AN-MK5 practice bombs. • These items were heavily concentrated along the western edge of Little Neck. Additional debris items were identified in the central and southern marsh area as well as along shoreline to the north and south of Little Neck. (4) **Potential Pathways:** • Munitions constituents (MCs) from bombs dropped on upland soils and beaches could adsorb onto organic matter particles, if present, or leach downward through the soil into groundwater. • MCs from items dropped in marshes would most likely be adsorbed to the organic matter that is characteristic of soils in these areas. However, more soluble constituents could migrate within surface water into adjacent surface water bodies. (2) • MEC items (i.e., practice bombs with spotting charges) have been identified in surface and subsurface soils. • Erosion of soil by water or wind may expose buried MEC items. • Munitions debris located in Cape Poge Bay may have been subject to transport via dredging activities.	**Current Landowners:** • The Trustees of Reservations (TTOR), the Commonwealth of Massachusetts (inland and coastal waters), and private landowners. (1) **Current Land Use:** • Part of the Cape Poge Wildlife Refuge. (2) • Currently, the AOI remains mostly undeveloped; however, there are several single-family residential homes located in the northern portion of Cape Poge. • The public has limited access, which is defined as some access to the former range, but that access doesn't involve any digging. (2) • Common property activities include, but are not limited to, sunbathing, swimming, four-wheel driving, picnicking, hiking, fishing, clamming, scalloping, crabbing and visiting the lighthouse. (2) **Future Land Use:** • It is anticipated that the future land use will remain the same. **Resource Identification:** • Based on information in the Massachusetts Department of Environmental Protection (MADEP) Geographic Information System (GIS), the area does not qualify as a non-potable use area and use of groundwater as potable supply must be assumed. **Potential Receptors:** • Potential MEC and MC receptors associated with current and future land use include residents, recreation users, on-site workers, and biota. (1) • There is concern that visitors have been moving bombs and concern over public digs in mudflats for clams. (1)	**Property Description:** • The site consists of upland sand dunes, lower areas consisting of marshes, mudflats, and inland waters. • The present land use includes primarily recreational use with little disturbance likely. **Potential Ecological Receptors:** • Inland and marine plant species, fish, birds, insects, soil invertebrates, and mammals that inhabit or migrate through the site. Associated threatened and endangered species are included. **Threatened and Endangered Species:** • There are approximately 37 federal/state threatened, endangered, and/or special concern species that could be present at the site. (1) **Relationship of Munitions Debris to Habitat:** • Munitions items may be located within and/or adjacent to habitat areas.

Notes:

(1) UXB International, Inc., 2011. *Final Revision 1, Remedial Investigation Work Plan, Former Cape Poge Little Neck Bomb Target MRS, Former Moving Target Machine Gun Range at South Beach MRS, & Tisbury Great Pond MRS, Martha's Vineyard, Massachusetts*. January.

(2) U.S. Army Corps of Engineers St. Louis District, 2009b. *Draft Report, Preliminary Assessment, Cape Poge Little Neck Bomb Target Site, Chappaquiddick Island, MA, FUDS Property – D01MA0595*. February.

(3) U.S. Army Corps of Engineers, 2008a. *Final, Site Inspection Report for Tisbury Great Pond*. September.

(4) U.S. Army Corps of Engineers, 2010. *Draft Final Site Specific Final Report For The Time Critical Removal Action (TCRA) at Former Cape Poge Little Neck Bomb Target Site, Chappaquiddick Island, Dukes County, Massachusetts, and Former Moving Target Machine Gun Range at South Beach, Martha's Vineyard, Edgartown, Massachusetts*. January.

the MK15 and the AN-MK43, which were constructed of steel and lead-antimony alloy, respectively (USACE, 2009b). However, they were not identified during the TCRA.

3.1.2 Release Mechanisms

3.1.2.1 Practice bombs used at the site have been identified on upland surface soil adjacent to the target, in marshes adjacent to the target area, on beaches, and within nearby surface water bodies (e.g., Cape Poge Bay, Shear Pen Pond, etc.). From these locations, ordnance would be exposed to weathering/corrosion processes, which could lead to the release of MCs into the environment.

3.1.3 Fate and Transport Processes

<u>MEC</u>

3.1.3.1 The ultimate fate of MEC items at the site is governed by various physical factors/transport processes. Due to the close proximity of the Atlantic Ocean to the historic target location, practice bombs may have landed on the eastern beaches of Cape Poge or in the Atlantic Ocean. At these locations, items containing MEC would be subject to ocean currents that may have facilitated the movement of these items out to sea or horizontally along the beach. Dredging operations, conducted during scallop harvesting, within Shear Pen Pond and Cape Poge Bay could have transported MEC items. Natural erosion over time of soil by wind or by water can result in the exposure of buried MEC by the removal of the overlying soil. Additionally, a major concern at the site is the movement of potential MEC items by the public. The public has been observed digging for clams using their hands and/or hand tools within the mudflats of the site. The public is also known to remove the practice bombs from the AOI (USACE, 2008b).

<u>MCs</u>

3.1.3.2 The major factors affecting the fate and transport of explosives are adsorption to soil particles and transformation of compounds by photochemical reactions. Explosives have varying chemical properties that affect their mobility in environmental media. 2-Nitrotoluene and nitrobenzene compounds are relatively soluble in water [650 to 2090 milligrams per liter (mg/L)], have relatively low organic carbon partition coefficients (K_{OC}) [4226 to 420 liters per kilogram (L/kg)] indicating that they do not adsorb strongly to soil, and are highly volatile [Henry's Law Constants (K_H) of 9.8e-4 to 1.25e-5]. Other explosives compounds, such as 2,4,6-trinitrotoluene (TNT), have lower solubility (115 mg/L), will adsorb to soil particles to a greater extent (2,812 L/kg), and are less volatile (K_H of 8.5e-7). In general, the solubility and volatility decrease with increasing number of nitro groups (i.e., 2-nitrotoluene exhibits greater solubility and volatility than TNT), while the adsorption capacity will increase with increasing nitro groups. Explosives compounds may also undergo transformation processes such as photolysis. TNT is highly unstable and will readily transform via photolysis. The explosives 1,3,5-trinitro-1,3,5-triazine (RDX) and oxyhydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX) are also affected by photolysis, but to a lesser degree (Brannon and Myers, 1997). RDX biological degradation occurs when RDX is reduced to the mono-,di-, trinitoso degradation products, which are formed by reduction of the nitro groups to nitroso groups. The anaerobic biodegradation pathway for RDX includes the degradation compounds; hexahydro-1-nitroso-3,5-dinitro-1,3,5-triazine (MNX), hexahydro-1,3-dinitroso-1,3,5-triazine (DNX), hexahydro-1,3,5-trinitroso-1,3,5-triazine (TNX). HMX undergoes a similar pathway.

3.1.3.3 Metals, once introduced into the environment, can exist in several states in the subsurface: ions dissolved in groundwater, bound ionically or adsorbed to the soil itself, retained by soil organic matter or organic compounds, or as precipitated solids (United States Environmental Protection Agency [USEPA], 1992). The metal forms present are dependent upon numerous factors including, pH, redoxomorphic potential, soil type, and soil organic matter.

3.1.3.4 Within the pH range of site soils (5.1 to 7.3), positively-charged metal forms present in soil (e.g., copper, lead, nickel, and zinc) have an affinity for soil adsorption sites, carbonates, phosphates, hydrous oxides, and iron and manganese oxides. In general, with decreasing pH, metal oxide, carbonate, and phosphate dissolution increases and adsorbed metals are released into solution. As such, with more metals in solution, competition for existing adsorption sites increases. Although antimony is present in soil and is positively charged, it frequently combines with hydroxyl groups to form a negatively charged ion. Due to the lower number of exchange sites capable of adsorbing negatively charged ions, antimony is typically more readily available in the soil solution. Unlike positively charged metal forms present at the AOI, under acidic and slightly acidic conditions, antimony can be more readily adsorbed to the soil and more readily available to complex thereby having the ability to decrease antimony mobility.

3.1.3.5 Oxidation/reduction reactions, or redoxomorphic potential, will affect the fate and behavior of metals in soil. Oxidation/reduction reactions can directly affect the mobility elements like iron, manganese, sulfur, which can affect the fate of the metals within the AOI. Since the majority of site soils consist of at least 19 inches of peat (a high-organic matter material), the:

- The reduction of the relatively immobile form of iron [Fe (III)] commonly associated with iron oxides to a more mobile of iron [Fe(II)] would release iron and other metals into the solution (e.g., antimony, copper, lead, nickel, and zinc);

- Available copper (Cu) and nickel (Ni) in solution decreases in reduced environments since the presence of reduced sulfur precipitates Cu and Ni to insoluble sulfide forms; Conversely, the process of oxidation tends to release Cu and Ni into solution; and,

3.1.3.6 The ability of soil types to adsorb metals (antimony, copper, lead, nickel, and zinc) can be approximated by the relative exchange capacity of the soil as well as the soil organic matter content. Since the site soils are low in clay content and much of the soil present within the AOI consists of peat, metals would be retained within the organic matter or would be precipitated as more insoluble forms.

3.1.4 Exposure Pathway Analysis

MEC

3.1.4.1 Exposure to MEC via surface and subsurface soil were evaluated and summarized on Figure 3-1. Based upon the exposure analysis, potential receptors for MEC include residents, recreational users, site workers, and biota.

MCs

3.1.4.2 Exposure to MCs via sediment/surface water, food chain, surface soil, subsurface soil, and groundwater were evaluated and the results are summarized on Figure 3-1. More detailed conceptual site models specific to human health and ecological exposure pathways are presented in Figures 7-1 and 7-2, respectively.

3.1.4.3 The sediment/surface water exposure pathway was evaluated for potential receptors through the ingestion and dermal contact exposure routes. Exposure of MCs through ingestion of sediment/surface water is considered complete for recreational users, site workers, and biota; and considered potentially complete for residents. Exposure through dermal contact is considered complete for all receptors.

3.1.4.4 The food chain exposure pathway was evaluated for potential receptors through the consumption of cultivated crops, native vegetation, and game/fish exposure routes. Exposure of MCs through consumption of cultivated crops is considered complete for residents and biota, potentially complete for recreational users, and incomplete for on-site workers. Exposure through consumption of native vegetation is considered complete for biota and potentially complete for residents, recreational users, and on-site workers. Exposure through consumption of game/fish is considered complete for residents, recreational users, and biota; and considered incomplete for site workers.

3.1.4.5 The surface soil exposure pathway was evaluated for potential receptors through the ingestion, dermal contact, and inhalation exposure routes. Exposure of MCs through ingestion of surface soil is considered complete for recreational users and biota, potentially complete for residents, and incomplete for site workers. Exposure through dermal contact and inhalation is considered complete for all receptors.

3.1.4.6 The subsurface soil exposure pathway was evaluated for potential receptors through the ingestion, dermal contact, and inhalation exposure routes. Exposure of MCs through ingestion of subsurface soil is considered complete for biota, potentially complete for residents and recreational users, and incomplete for on-site workers. Exposure through dermal contact is considered complete for biota and incomplete for residents, recreational users, and site workers. Exposure through inhalation is considered potentially complete for all receptors.

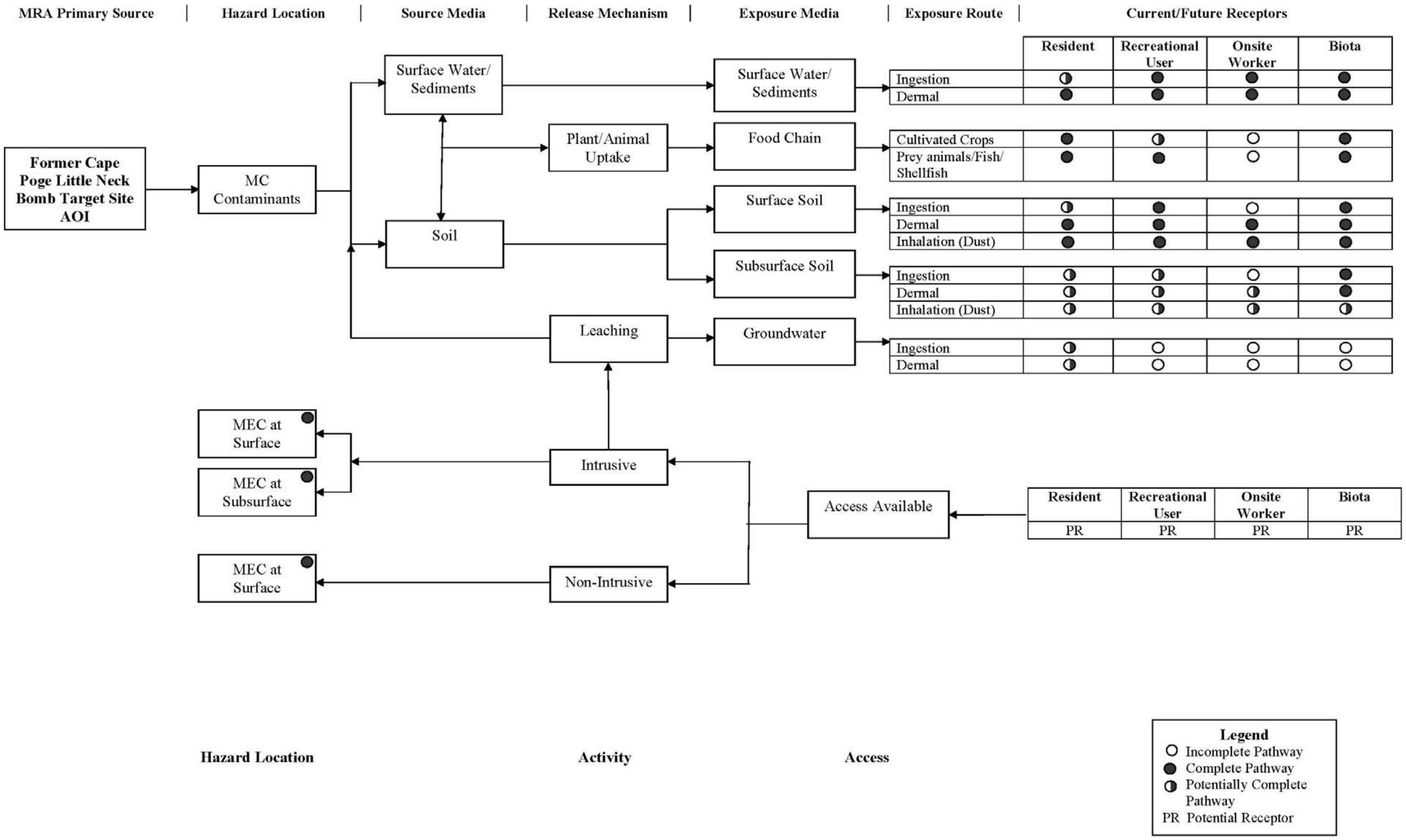
3.1.4.7 The groundwater exposure pathway was evaluated for potential receptors through the ingestion and dermal contact exposure pathway. Exposure of MCs through these pathways was considered potentially complete for residents and incomplete for all other receptors.

3.2 Preliminary Remediation Goals

3.2.1 Preliminary Remediation Goals were developed for MEC, MPPEH, and MD as well as associated MCs. For MEC, MPPEH, and MD, the Preliminary Remediation Goals include characterizing the nature and extent of these items and reducing the associated risks. To meet these Preliminary Remediation Goals, a geophysical survey and visual inspection were conducted to identify MEC, MPPEH, and MD items as well as subsurface anomalies. Once anomalies were identified, an intrusive investigation was conducted on all anomalies that met or exceeded selection criteria for MEC. To reduce the risk associated with MEC, these items were removed and destroyed.

3.2.2 The Preliminary Remediation Goals for MCs are the screening criterion identified during the TPP Process to be protective of human health and ecological receptors. If environmental media containing MCs above the screening criterion are identified, the media should be addressed to mitigate risks to human health and the environment. To evaluate relevant MCs, environmental media (i.e., soil, sediment, and groundwater) were sampled and analyzed for MCs that were potentially released at the site. Additionally, a screening level HHRA and SLERA were conducted to determine if any MCs required additional assessment. Constituents exceeding the applicable regulatory criterion, will be further evaluated in a baseline HHRA following the USEPA risk assessment guidance (USEPA, 1989) and an ecological risk assessment (ERA) in accordance with current guidance including the 2001 USEPA Supplemental Guidance to Risk Assessment Guide for Superfund (RAGS), Ecological RAGS (USEPA, 1997), and the Massachusetts Method 3 Risk Characterization methodology under the MCP (MADEP, 1996). Applicable screening criterion are provided in Table 3-2.

Figure 3-1. **Conceptual Site Model Summary**



	Resident	Recreational User	Onsite Worker	Biota
Ingestion	◑	●	●	●
Dermal	●	●	●	●
Cultivated Crops	●	◑	○	●
Prey animals/Fish/ Shellfish	●	●	○	●
Ingestion	◑	●	○	●
Dermal	●	●	●	●
Inhalation (Dust)	●	●	●	●
Ingestion	◑	◑	○	●
Dermal	◑	◑	◑	●
Inhalation (Dust)	◑	◑	◑	◑
Ingestion	◑	○	○	○
Dermal	◑	○	○	○

Resident	Recreational User	Onsite Worker	Biota
PR	PR	PR	PR

Legend
○ Incomplete Pathway
● Complete Pathway
◑ Potentially Complete Pathway
PR Potential Receptor

Table 3-2. Human Health and Ecological Screening Criterion
Former Cape Poge Little Neck Bomb Target Area of Investigation

Media of Concern	Screening Criterion	
	Human Health	Ecological
Soil	Criteria for human health were identified as the lower of: 1. USEPA Residential Risk Screening Level 2. MADEP Method 1 Soil Standard (S1 value selected as most stringent)	Criteria for ecological were identified as the lower of: 1. USEPA EcoSSL (lowest of avian, mammalian, plant, or invertebrate) 2. Region 5 ESL 3. Region 4 ESV
Sediment	n/a	Criteria for ecological endpoints identified as lower of: 1. Region 5 ESL 2. Region 3 Freshwater Screening benchmark 3. MADEP Freshwater Sediment Screening benchmarks 4. Region 6 Toxicity Reference Values 5. Los Alamos National Laboratory ECORISK Database Release 2.5 6. 1,3-nitrobenzene (surrogate for 1,2-isomer Region 4 ESV)
Groundwater	USEPA MCLs	n/a

Notes:
ESL - Ecological Screening Level
ESV - Ecological Screening Value
ESL - Ecological Soil Screening Level
MADEP – Massachusetts Department of Environmental Protection
MCL – Maximum Contaminant Levels
SSL – Soil Screening Level
USEPA – U.S. Environmental Protection Agency
n/a – not available

3.3 Preliminary Identification of ARARs and TBC Information

3.3.1 As part of this RI, a list of potential ARARs [in accordance with 40 Code of Federal Regulations (CFR) §300.415(j)] and TBC information were identified. This information influences the development of remedial alternatives by establishing numerical clean-up levels, permitting, siting, disposal, operating parameters, health and safety, and monitoring standards.

3.3.2 The following five criteria that must be met for a standard, requirement, criteria, or limitation to be considered an ARAR:

1. The requirement must be promulgated;
2. The requirement must be related to a Federal/State environmental law or state siting law;
3. The requirement must be substantive;
4. The requirement must be a cleanup standard, standard of control, or requirement that specifically addresses a CERCLA hazardous substance, pollutant, or contaminant; remedial action; or remedial location; and,
5. The requirement must be applicable or relevant and appropriate.

3.3.3 Non-promulgated advisories or guidance issued by federal or state governments are not legally binding and do not have the status of ARARs. Such requirements may, however, be useful and are TBC. TBC requirements (40 CFR §300.400[g][3]) complement ARARs but do not override them. They are useful for guiding decisions regarding cleanup levels or methodologies when regulatory standards are not available.

3.3.4 A list of the potential ARARs and TBC information for activities at the AOI are provided in Table 3-3.

Table 3-3. Potential ARARs
Former Cape Poge Little Neck Bomb Target Area of Investigation

Standard, Requirement, Criteria, or Limitation	Citation	Description	Potential ARARs or TBC
Federal Requirements			
Archaeological Resources Protection Act of 1979	32 CFR 229.4 as promulgated in 16 U.S.C. §470ee	The Act makes it unlawful for any person to excavate, remove, damage, or otherwise alter or deface, or attempt to excavate, remove, damage, or otherwise alter or deface any archaeological resource located on public lands or Indian lands unless such activity is pursuant to a permit.	ARAR
Endangered Species Act	16 U.S.C. §1538(a)(1)(B)	The Act makes it unlawful for any person to take an endangered species located within the United States or the territorial sea of the United States.	ARAR

Notes:
ARAR - Applicable or Relevant and Appropriate Regulation
CFR - Code of Federal Regulations
U.S.C. - United States Code

3.4 Summary of Institutional Analysis

3.4.1 An Institutional Analysis Report will be prepared to support the development of institutional controls as a munitions response alternative as part of the FS. The report is not included in Appendix B of this RI Report. The objective of this analysis is to gather background information and document which government agencies have jurisdiction over the subject property and to assess the capability and willingness of these entities to assert institutional controls that would protect the public from potential explosive hazards present at the site. While property owners are not included in this process, they will be involved in any decision making process affecting their property. Based on the preliminary institutional analysis, the government agencies potentially involved with asserting institutional controls includes:

- TTOR;
- The Town of Edgartown; and,

- The Town of Edgartown – Shellfish Department.

3.5 Data Needs and Data Quality Objectives

3.5.0.1 The following sections discuss the data needs identified for the AOI and the DQOs developed to ensure that these data needs are met. The data needs and project objectives for this RI were discussed and agreed upon by the TPP team, which consisted of:

- USAESCH;
- CENAE;
- TTOR;
- UXB;
- AMEC (subcontractor);
- VRHabilis (subcontractor);
- Aqua Survey (subcontractor);
- MADEP;
- USEPA;
- Town of Edgartown;
- Massachusetts Department of Conservation and Recreation; and,
- Cape Poge Shellfish Constable.

3.5.1 Data Needs

3.5.1.1 An evaluation of existing data was conducted to determine the data needs and the methods required to fulfill those needs. The evaluation of existing data can be found in Section 3.1, *Conceptual Site Model and Project Approach*, which confirmed the use and presence of military ordnance at the site. Previous investigations concluded that further investigation may be needed. The data needs were reviewed by the TPP team and several suggestions by the team affected the type of data to be collected at the site. During the TPP process, the TPP team agreed to the following investigation requirements:

TPP Meeting #1

- Conduct incremental sampling for surface soil samples and collect discrete samples for subsurface soil samples.
- Analyze explosives and a limited list of inorganics associated with munitions used (AN-MK23).

- Compare analytical results against the USEPA Regional Screening Levels (RSLs) (Master Table, December, 2009) or MADEP delineation criteria, whichever is more stringent.

TPP Meeting #2

- Conduct aerial geophysics for each AOI.
- Develop a flyer to inform scallopers of how to handle munitions debris.
- Do not conduct seeding in Shear Pen Pond.
- Conduct blind seeding on grids only. Conduct blind seeding on all water except ocean.

TPP Meeting #3

- Surface water sampling is not required.
- Conduct shellfish sampling.
- Sample all public water supplies, including the Cape Poge Lighthouse.
- Sample a subset of domestic wells with consideration to well construction and filtration.
- Consult with Shellfish Constables regarding shellfish sampling.

Follow-up Conference Call to TPP Meeting #3

- Implement a phased approach to groundwater sampling. Initially, four grab samples will be collected using Small Diameter Driven Well technology approved by MADEP. One sample will be collected in the vicinity of the public well at the lighthouse, one sample will be collected at the historic target area, and the remainder will be collected in the vicinity of the two residential wells. Background samples will be collected if results indicate groundwater concentrations exceed human health screening criterion.
- Discrete, biased sediment samples will be collected to determine if MCs are present. Five samples will be collected from Drunkard's Cove and one sample in each geophysical investigation grid within Shear Pen Pond and Cape Poge Bay. Background samples will not be collected unless MCs are detected above human health screening levels. The number of sediment samples will be determined after consultation with risk assessor(s).
- The necessity of biological sampling at the AOI will be determined based on the results of sediment sampling. If sample results indicate impacts to the identified ecological screening levels in Step 2 of the SLERA, then the ERA will proceed to Steps 3 and 4, which may include tissue sampling.
- Collect surface and subsurface soil samples (incremental sample in target area and discrete, biased samples in other areas). It is recommended that the incremental samples

consist of more than 30 aliquots (between 75 and 100) selected by the systematic random sampling procedure. Discrete samples are recommended within areas with the greatest MEC density.

- A residential well survey may be provided in the RI Report depending on groundwater sampling results.

3.5.1.2 Although the AOI has been the subject of multiple investigations, these investigations have not characterized the complete nature and extent of MEC, MD, and MCs at the site. Therefore, further investigation is needed to quantify the extent of MEC and MCs. Data gaps identified during the TPP process include:

- Potential release points for MCs present within environmental media have not been characterized;
- Identification of MCs within environmental media has not been performed;
- Nature and extent of MEC, MD, and MCs have not been characterized; and
- Adequate data has not been collected to define the potential risks associated with MEC and MCs present in defined media.

3.5.2 Data Quality Objectives

3.5.2.0.1 DQOs are outputs derived from the seven-step DQO process that are used to guide environmental data collection activities (USEPA, 2000). This process provides a systematic approach for defining the criteria that a data collection design should satisfy. DQOs are qualitative and quantitative statements that define the purpose of the investigation, what the data collected should represent to satisfy the objectives of the investigation, and specify the quality of data required to support decisions made during the investigation. The overall project objectives with respect to data quality are to obtain data that are technically sound and legally defensible. This is accomplished through the proper implementation of field sampling and surveying procedures, field logs and chain of custody (COC) documentation, controlled laboratory analysis, and validation of the reported data prior to their use. A discussion of the DQOs for each investigation element performed during this RI is provided in the following subsections.

3.5.2.1 Geophysical Investigation

3.5.2.1.1 The overall objective of the geophysical investigation is to define the nature and extent of MEC, MPPEH, and MD. To ensure that the activities conducted during the geophysical investigation satisfy this objective, the following geophysical DQOs were developed.

3.5.2.1.2 DQO 1 – The MEC footprint will be defined such that a representative boundary of MEC contamination is discerned.

3.5.2.1.3 The extent of MEC and MD at the AOI was defined through the collection of geophysical data (analog and digital) within land, beach, inland water, and ocean areas.

3.5.2.1.4 DQO 2 – The total geophysical acreage surveyed should be a minimum of 0.75 percent of the total MRS (or AOI) acreage for a statically valid survey to result.

3.5.2.1.5 The total acreage surveyed on land, beach, inland water and ocean is 17.18 acres, or 2.15 percent of the total acreage (800 acres) of the AOI.

3.5.2.1.6 DQO 3 – The coordinates obtained from the positioning system used on the grid surveys will be of sufficient accuracy to allow for appropriate relocation of MEC items for intrusive investigation.

3.5.2.1.7 This DQO was achieved by collecting data with the real time kinematic (RTK) global positioning system (GPS) system over a known point. All collected data was within the required 4 in. [10 centimeters (cm)].

3.5.2.1.8 DQO 4 – Have sufficient data collected along each line to detect munitions items.

3.5.2.1.9 This DQO was achieved by calculating the percentage of sequential data points separated by more than 25 cm to ensure that the number of readings that fell outside did not exceed 5 percent.

3.5.2.1.10 DQO 5 – Maintain appropriate lane spacing to provide greater than 90 percent coverage at project line spacing (2.5 ft).

3.5.2.1.11 This DQO was achieved by evaluating the collected data through the generation of footprint coverage maps.

3.5.2.1.12 DQO 6 – Anomaly characteristics (peak response and downline width) will be repeatable to greater than or equal to 65 percent of expected minimum value.

3.5.2.1.13 This DQO was achieved by comparing the test item coordinates and response in the instrument verification strip (IVS) against the initial day’s results.

3.5.2.1.14 DQO 7 – Anomaly characteristics (peak response and downline width) will be repeatable within 0.73 meters (m) of original location for data positioned with GPS and 0.88 m of the original location if fiducial positioning is used.

3.5.2.1.15 This DQO was achieved by comparing the DGM selected target location to the intrusive dig location.

3.5.2.1.16 DQO 8 – The DGM system will respond consistently from the beginning to the end of an operation.

3.5.2.1.17 This DQO was achieved by evaluating the static test results to ensure that the static response did not exceed +/-10 percent after background correction when using a fixed jig for the spike test.

3.5.2.2 Munitions and Explosives of Concern Intrusive Investigation

3.5.2.2.1 The DQOs for MEC intrusive investigation activities performed and a summary of how each of these DQOs were accomplished are provided below.

3.5.2.2.2 DQO 1 – MEC will be uniquely identified as to type, condition, orientation, etc.

3.5.2.2.3 This DQO was achieved by conducting intrusive investigations within 49 grids resulting in the identification and recovery of 88 MEC items.

3.5.2.3 Munitions Constituents Investigation

3.5.2.3.1 The DQOs for MC field investigation activities performed and a summary of how each of these DQOs were accomplished are provided below.

3.5.2.3.2 DQO 1 – Field and Analytical performance/acceptance criteria per method as detailed in the U.S. Department of Defense (DoD) Quality Systems Manual (QSM) Version 4.2 and defined on Worksheet #12 in the approved RI Work Plan (UXB, 2011).

3.5.2.3.3 All data was collected and analyzed in accordance with the procedures, methods, and performance/acceptance criteria detailed in the DoD QSM Version 4.2 and defined in Worksheet #12 of the UFP-QAPP in the approved RI Work Plan (UXB, 2011).

3.5.2.3.4 DQO 2 – The quantity and location of samples is acceptable when nature and extent is determined using the Decision Rules identified in Worksheet #12, Step 5, in the approved RI Work Plan (UXB, 2011).

3.5.2.3.5 This objective was achieved by conducting incremental and discrete soil sampling as well as discrete sediment and groundwater sampling within the AOI in accordance with the approved RI Work Plan (UXB, 2011). Samples were analyzed by the contracted laboratory for the project-required explosive analytes [NG, dinitrotoluene (DNT), and DNT breakdown products (2,4-DNT, 2,6-DNT, 2-amino-4,6-DNT, 2-nitrotoluene, 3-nitrotoluene, 4-amino-2,6-DNT, and 4-nitrotoluene] using EPA Method 8321B, and select metals (antimony, copper, iron, lead, nickel, and zinc) using Method 6020A. Based upon the results of initial soil, sediment, and groundwater sampling, all decision rules contained within Step 5 were satisfied.

3.5.2.3.6 DQO 3 – SW 846 Methods will provide an acceptable detection limit and accuracy for use in decisions related to attaining cleanup goals.

3.5.2.3.7 All analytical data were analyzed using analytical methods listed in the UFP-QAPP.

3.5.2.3.8 DQO 4 – The laboratory will review and apply usability qualifiers to the analytical data.

3.5.2.3.9 The scope of work defined for the contracted laboratory includes data review and the use of usability qualifiers for all analytical results, where applicable.

3.5.2.3.10 DQO 5 – All data will be verified using the Automated Data Review (ADR) software tool.

3.5.2.3.11 All analytical data was verified by AMEC and USAESCH using ADR software.

3.5.2.3.12 DQO 6 – A data validation will be conducted on 100 percent of the analytical; data by an experienced chemist to assess the data usability. The data usability will then be evaluated by the appropriate agencies for final approval.

3.5.2.3.13 Data validation was performed on 100 percent of the analytical data by the AMEC qualified chemist.

4.0 CHARACTERIZATION OF MEC AND MCs

4.0.0.1 The objective of this RI was to collect data necessary to determine the nature and extent of MEC, MD, and MCs; evaluate the potential risks to human health and the environment; and support the development of an FS to evaluate future response actions, if necessary. To achieve these objectives, various field investigative activities were conducted; including, geophysical surveying of land, beach, inland waters, and ocean waters; intrusive investigations of anomalies; and environmental sampling of soil, sediment, and groundwater for analysis of MCs. This section presents a summary of the field activities conducted during this RI.

4.1 Site Preparation

4.1.0.1 Prior to MEC and MC characterization activities, several preparation activities were conducted including a utility clearance, obtaining an underwater archaeology permit, and vegetation/brush clearing. A utility clearance was conducted at proposed drilling locations to ensure no impacts to underground utilities would result from drilling activities. An underwater archaeology permit was obtained prior to MEC investigation activities in the ocean in accordance with the Board of Underwater Archaeological Resources special use permit 10-003 (Appendix C). Finally, vegetation was cleared as necessary to allow access for personnel and equipment during the geophysical investigation. While performing brush clearing activities, sensitive ecosystems and endangered/protected plant species were avoided in accordance with the Environmental Protection Plan (UXB, 2011).

4.2 MEC Characterization

4.2.0.1 This section details the approach, methods, and operational procedures used during MEC characterization activities. The overall goal of MEC characterization activities was to delineate the nature and extent of MEC within the AOI. To accomplish this goal, characterization activities were conducted in a phased approach that included:

- Collection of geophysical data via instrument-aided reconnaissance and DGM;
- Data processing and interpretation;
- Dig sheet development; and,
- Intrusive investigation.

4.2.0.2 A project sequence overview is presented in Figure 4-1 to understand the chronology of activities conducted at the AOI.

4.2.0.3 Field activities were conducted from a rented house in Edgartown, Massachusetts, which was used as the field office and the central command post during investigation activities. The field office was used as a location to store equipment and supplies, health and safety records, material

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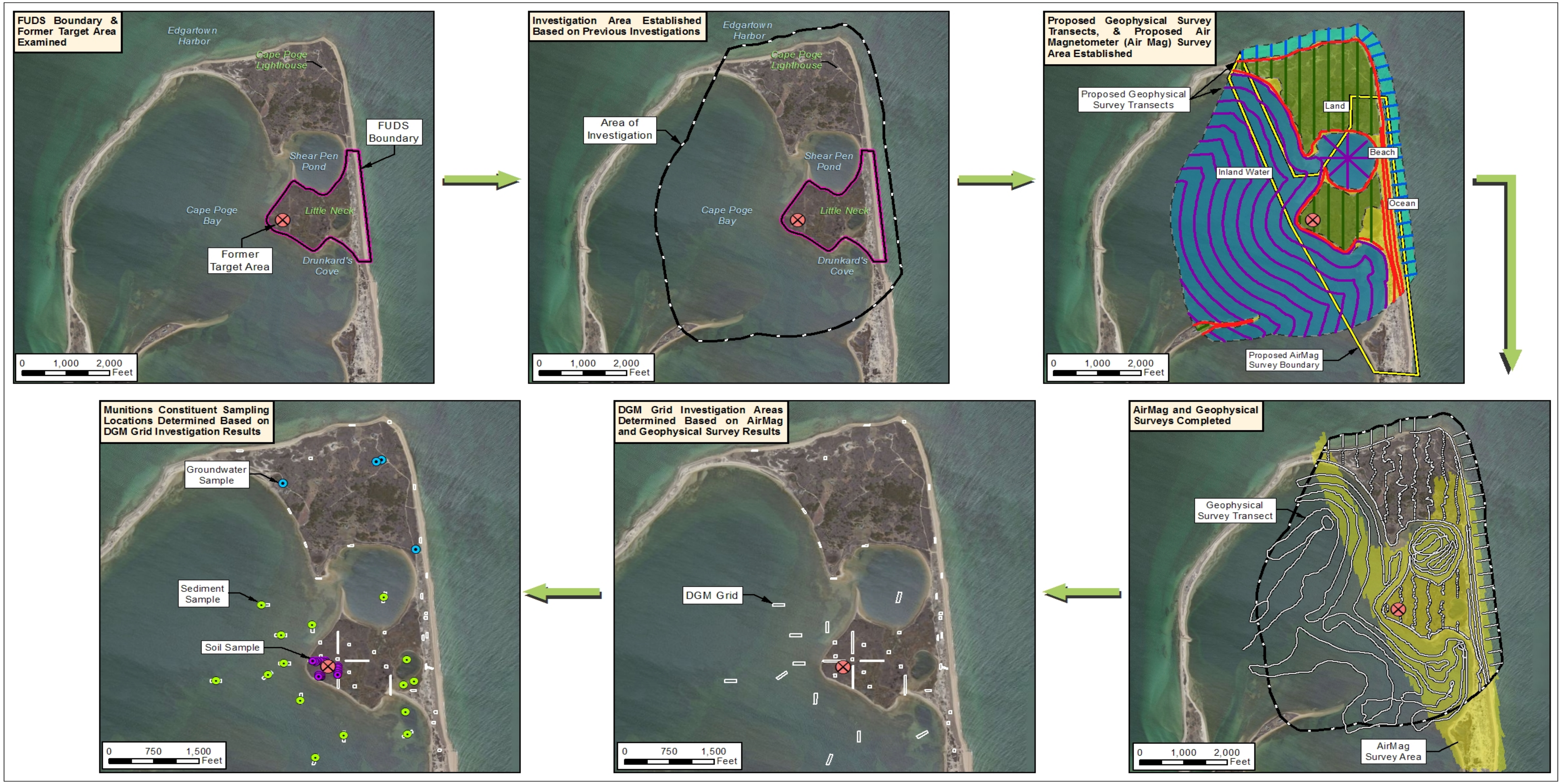
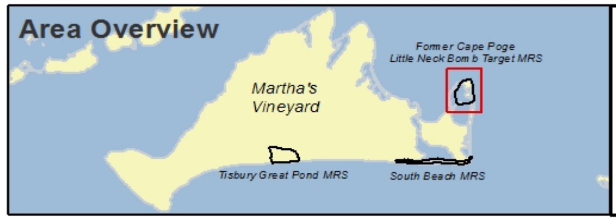




US Army Corps of Engineers

FIGURE 4-1

Project Sequence Overview - Former Cape Poge Little Neck Bomb Target Area of Investigation
Martha's Vineyard, MA

N

- SCALE AS SHOWN -

UXB amec

NOTES:
2011 Aerial Data Source: Bing Maps, Microsoft Corp.

05/03/2012	Rev:	CPoge_Dec_Logic_Flowcht_Remedial_Inv_Rpt.mxd
Drawn: JBO	Chk: DMS	PROJ: 562910000

safety data sheets, site maps, and project documents as well as park vehicles necessary to complete the field investigation.

4.2.1 Geophysical Investigation

4.2.1.0.1 A geophysical investigation was conducted to delineate the nature and extent of surface and subsurface metal debris. This objective was achieved by measuring variations (anomalies) in both local magnetic and electromagnetic fields. Geophysical surveying was conducted during two phases of work. During the first phase, geophysical data was collected along linear, reconnaissance transects located throughout the AOI, and supplemented with an AirMag survey. During the second phase, the nature of the anomaly source was investigated by either DGM over selected grids and intrusively investigating all anomalies that met or exceeded selection criteria for MEC within the grids, or reacquiring and intrusively investigating anomalies located along transects investigated during the first phase.

4.2.1.0.2 Prior to conducting the geophysical survey, the AOI was subdivided into four sub-area types according to sub-area geomorphology, which are listed and defined below.

- Beach – the land immediately adjacent to either marine or fresh water;
- Land – all land excluding beaches and dunes;
- Inland Water – protected marine or fresh water environments, such as coves or ponds; and,
- Ocean – those waters directly associated with the Atlantic Ocean, Vineyard Sound or Nantucket Sound.

4.2.1.0.3 The geophysical investigation was designed such that the type of geophysical methods and instrumentation proposed were appropriately matched to the unique character of the sub-area. Analog magnetometry transects were completed in land and ocean areas, and beach and inland water areas were investigated using digital EM methods and instrumentation as summarized in Table 4-1.

Table 4-1. Analog, DGM Transect, and Grid Coverage
Former Cape Poge Little Neck Bomb Target Area of Investigation

Area	Transects (miles)	Transects (acres)	Grids (acres)
Land	6.50	2.59	2.10
Beach	5.23	2.08	0.91
Inland Water	16.15	6.42	2.40
Ocean	1.47	0.58	0.00

4.2.1.1 Wide Area Assessment

4.2.1.1.1 During geophysical surveying, a wide area assessment was initially performed to help identify large areas of geophysical anomalies that might be indicative of an area previously used as a military target, aid in determining the extent of potential MEC contamination, and focus subsequent detailed intrusive investigation. The wide area assessment consisted of:

- Analog density transects in the upland areas using hand-held analog instruments to minimize the amount of brush clearing;
- DGM transects on the beach area where no vegetation clearing was required using a cart-mounted EM61coil; and,
- Underwater DGM in the inland water areas using a marine version of the EM61 coil towed behind a small boat.

4.2.1.1.2 This work was supplemented with an AirMag survey performed using an AirMag array mounted to a helicopter and flown over the land, beach, and shallow inland water/surf zone at 3 to 10 ft above the surface.

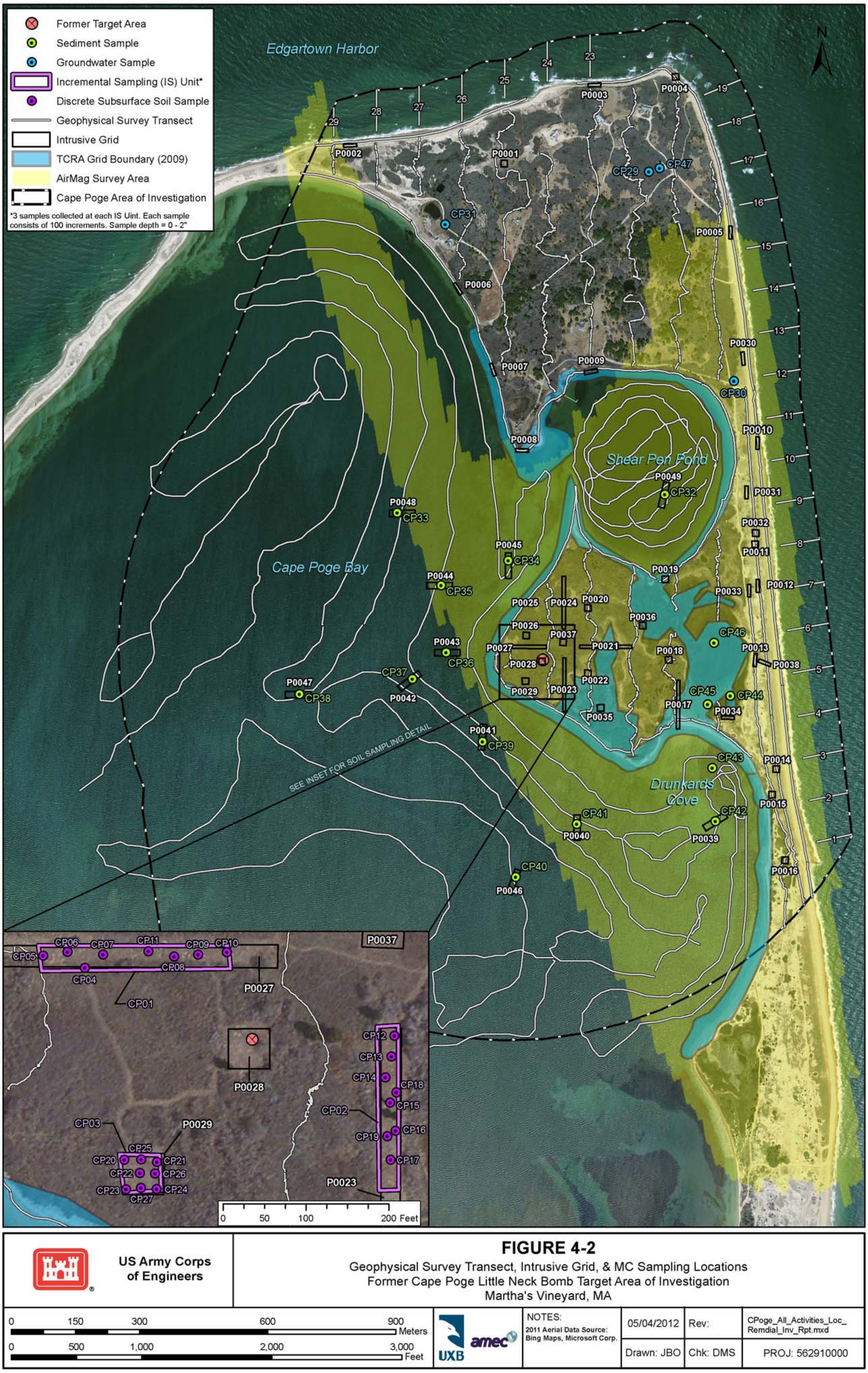
Airborne Magnetometry

4.2.1.1.3 Between 6 February and 18 February 2011, a low-altitude airborne vertical magnetic gradient geophysical survey was conducted by Battelle Oak Ridge Operations using Battelle’s VG-22 airborne vertical gradient magnetometry system. AirMag was utilized as a wide area assessment tool to provide reconnaissance level magnetometry data over a large percentage of the AOI to detect spatially large areas of elevated anomalies, which may be indicative of the presence of a historical aerial bombing target. The objective of the survey was to collect high resolution AirMag data to detect groupings and clusters of MEC and MD items.

4.2.1.1.4 The AirMag survey was conducted over approximately 347 acres within the AOI, predominantly over non-residential land and limited portions of shallow inland water and ocean waters just off-shore (Figure 4-2).

4.2.1.1.5 Preliminary modeling suggested that the height of the airborne system above the ground may limit the resolution of detection such that a single AN-MK23 practice bomb may not be detected; however, concentrated contamination with AN-MK23 and MD would likely prove detectable. To test the data limits of AirMag at the AOI, test flights were performed over a specially installed IVS at the Martha’s Vineyard Airport. The results of the test flights suggested that the AirMag survey could successfully identify a highly contaminated aerial bombing target if one were present but would not likely identify a single AN-MK23 practice bomb. The results of the test flights are presented in Appendix A.

Figure 4-2. **Geophysical Survey Transect, Intrusive Grid, & MC Sampling Locations**



4.2.1.1.6 An IVS of ten representative target items was established at Martha’s Vineyard airport and used to verify positioning and system operation. The target items were laid on the surface and the line was flown at 1 to 2 m altitude during each day of project operations. Data were also acquired at a suite of altitudes ranging from 1 to 5 m for sensitivity assessment.

Analog Frequency-Domain Electromagnetic Detectors

4.2.1.1.7 Analog transect surveys were conducted on land within the AOI by UXB using a MineLab brand model F3 Frequency-Domain Electromagnetic (FDEM) induction “all-metal” detectors. This model was chosen for use at the AOI because of the historical use of the AN-MK5 practice bomb, which is composed of a zinc alloy that is non-ferromagnetic and thus not detectable using strictly magnetic-based sensors. The “all-metal” detector can detect the nearby presence of metallic objects (including, but not limited to ferromagnetic objects) by producing a “known” local EM field that induces a secondary EM field in the nearby metal object. This secondary field perturbs the known transmitted EM field, thus producing an EM “anomaly” in the return signal. (FDEM instruments generate the known EM field via a transmitting antenna, sometimes referred to as a transmitter coil, and detect the secondarily induced perturbations via an EM receiver antenna or Receiver coil).

4.2.1.1.8 The objective of the transect surveys was to locate areas of elevated concentrations of geophysical anomalies that might represent potential historical military target areas or areas impacted with MEC or MD. Analog “Bin Lines” were collected along 16 transects that were spaced approximately 100 m apart and crossed the AOI at 100 m spacing. A “Bin Line” is a geophysical transect surveyed using an analog instrument where all surface and subsurface anomalies are counted and recorded in a hand-held data logger. The data logged information includes differentiating the types of items found on the surface and a sum count of all subsurface anomalies within the “bin.” Transect spacing was determined using the software application Visual Sample Plan. The design was developed such that if remains of an aerial bombing target were to be present, there would be a statistical probability of greater than 95 percent that the target would be traversed and detected by the geophysical surveyors. The input target type was an aerial bombing target for an AN-MK23 practice bomb and the design anticipated traversing a target of this type on at least 7 of the installed transects. The acreages of analog transects and DGM grids surveyed within the AOI are shown in Table 4-1 and the actual transect locations are shown on Figure 4-2. During the analog reconnaissance, transects were surveyed using Trimble GeoXT Wide Area Augmentation System (WAAS) enabled GPS units that provided sub-meter accuracy.

Digital Geophysical Mapping

4.2.1.1.9 DGM included the collection of data along transects and within grids located throughout the AOI. A discussion of DGM within grids can be found in Section 4.2.1.2. Land

and beach DGM transects were surveyed by NAEVA Geophysics, Inc. (NAEVA), and inland water transects were surveyed by Aqua Survey, Inc. (Aqua Survey).

4.2.1.1.10 Between 6 December and 17 December 2010, NAEVA performed DGM transects (land-based) at the AOI. DGM was performed using the Geonics® EM61-MK2 time-domain metal detector integrated with a Trimble 5700 RTK GPS system. The EM61-MK2 is a high-resolution time-domain EM instrument designed to detect, with high spatial resolution, shallow ferrous and non-ferrous metallic objects. The EM61-MK2 system consists of two air-cored coils, a digital data recorder, batteries, and processing electronics. The EM61-MK2's transmitter generates a pulsed primary magnetic field, which then induces eddy currents in nearby metallic objects producing a secondary magnetic field. Each of the two spatially separated receiver coils measures these secondary fields. The EM61-MK2 offers the ability to measure the secondary fields at three distinct time intervals in the bottom coil or four intervals if no top coil measurements are recorded. Earlier time gates provide enhanced detection of smaller metallic objects. Secondary voltages induced in both coils by the secondary magnetic field are measured in millivolts (mV). Target resolution of approximately 0.5 m is expected with the system. EM61-MK2 data were initially stored in a hand-held data logger or field personal computer. Following the completion of each data file, data were transferred to a laptop computer for preliminary evaluation and editing.

4.2.1.1.11 Digital geophysical data were acquired at a walking pace in a person portable fashion (EM61 MK2 integrated with RTK GPS). Bottom coil height was maintained at the standard height of 40 cm above the ground by mounting the system on manufacturer supplied wheels. A Trimble TSC2 survey controller connected to the integrated RTK GPS system was used to follow the intended path of each transect. Navigation with GPS was accomplished with a single GPS sensor mounted over the center of the coil to provide real-time positional tracking capabilities. The instrument was operated in 4-Channel mode, recording secondary voltages in the bottom coil at four time gates. If vegetation or site conditions precluded collection along the intended path, the operator veered around the obstacle and continued back on path. For transects intended for beach areas that are currently underwater due to beach erosion, data collection was done at low tide as close to the water line as possible.

4.2.1.1.12 During land-based geophysical data collection, NAEVA installed an on-site IVS for quality control (QC) and validation of the EM61-MK2 system. Transect data were collected, processed, and reviewed. Raw data, processed data, final data, associated reports, and target lists were delivered to UXB in the specified formats.

4.2.1.1.13 Between 16 December 2010 and 15 March 2011, Aqua Survey collected data along inland water transects within Cape Poge Bay, Shear Pen Pond, and Drunkard's Cove. Initially, bathymetric and side scan sonar surveys were conducted within the AOI. The bathymetric survey was conducted using an Innerspace 455 survey-grade fathometer with narrow beam 200 kilohertz (kHz) transducer. The side scan sonar survey was conducted using an Edgetech 4125 dual frequency sonar operating at 400 kHz and 900 kHz. Data was collected along parallel survey lines spaced 25 ft apart. Data was processed and a side scan sonar mosaic and bathymetric contours were created to assist with the planning of EM transects.

4.2.1.1.14 Between 4 March and 15 March 2011, EM transect data was collected using a Geonics EM61-Mk2 high power console and underwater coil on either a boat-towed cart or a pole-mounted coil system. The rolling cart was used to collect transect data in water up to 18 ft deep, and the pole-mounted system was used for collecting data in deeper water. The altitude of the coil was tracked and adjusted real-time to insure it was within the specified altitude metric. A total of 25,225 m of transect data were collected.

4.2.1.2 Grid Selection and Mapping

4.2.1.2.1 Data collected during the wide area assessment was subsequently used to site grids for additional DGM surveying and intrusive investigation within inland water, land, and beach areas. Based on the results of the wide area assessment, anomalies were identified, mapped using ESRI ArcGIS, and analyzed for areas of elevated concentrations of anomalies. All anomalies from available data sets were evaluated, including AirMag, analog land transects, DGM land transects, and DGM inland water transects. The grids were sited in areas of high, medium, and low anomaly densities to refine the extent, and establish the nature of MEC contamination through subsequent intrusive investigation. Areas of elevated anomaly densities were then used to determine the size and location of grids over which additional DGM data would be collected. The grid sizes were chosen based upon the relative number of anomalies in that area of the AOI. In areas where the anomaly density was only slightly elevated, a larger grid (e.g. 100-ft by 100-ft square or equivalent square-footage) was used such that the best estimate of anomaly density could be determined. In areas where the anomaly density was relatively high, small footprint grids were used (50-ft by 50-ft square grids). In areas where delineating the lateral boundary of an anomaly cluster was the objective, long, narrow grids were installed (e.g., 50-ft by 200-ft rectangles). Proposed grid sizes and locations were presented to the USACE for concurrence prior to final placement. A weekly conference call conducted between the USAESCH, CENAE, and UXB, for which minutes were prepared, was typically held to discuss decisions related to proposed grid locations and anomaly selections.

4.2.1.2.2 NAEVA returned to the AOI from 28 February to 1 April 2011. During this time, NAEVA mapped land-based grids based off analog and DGM transects as well as AirMag data. The objective of the DGM grid surveys was to characterize all geophysical anomalies within localized areas as suggested by the results of the wide area assessment.

4.2.1.2.3 The DGM survey was conducted within grids using appropriate EM61 coil, and location of each anomaly recorded using an integrated RTK GPS unit. Thirty-eight land DGM and 11 inland DGM water grids were located within the AOI. Geophysical data were collected in the grids by towing the EM sensor system by hand (land grids) or by boat (inland water grids). For each land grid setup, consisting of either a 100-ft by 100-ft grid or a 50-ft by 50-ft grid, measuring tapes were stretched along the grid to be surveyed and ropes were laid out at 25-ft intervals across the direction of travel. Each rope had marks painted every 2.5 ft, which allowed the operator to walk straight lines of overlapping coverage. Data coverage was monitored in the field using Geomar's Nav61MK2 data collection program. DGM data collection within grids used an EM61-MK2

4.2.1.2.4 Between 19 and 29 April 2011, inland water grids were surveyed within the AOI. A total of 11, 60 m by 13 m grids were surveyed. Grid data was collected using the same EM system and cart as was used during the transect survey. Data was logged both within the designated grids and in the turn arounds resulting in additional coverage and anomalies for investigation.

4.2.1.3 Geophysical Data Processing

4.2.1.3.0.1 Prior to intrusive investigation, DGM data collected within the grids were evaluated and "picks" were made of anomalies to be intrusively investigated. Geosoft Oasis Montaj and ESRI ArcMap were used for analog transects. Geosoft Oasis Montage for DGM data post processing, in conjunction with ArcMap. The following subsections discuss the data analysis process followed to identify intrusive investigation areas.

4.2.1.3.1 Data Storage and Initial Editing

4.2.1.3.1.1 EM61-MK2 data were stored in an Allegro CX data logger using Geomar's Nav61MK2 software and then downloaded into a laptop computer for further on-site processing using Geomar's TrackMaker61MK2 software.

4.2.1.3.1.2 Daily logs, QC, and grid field information forms were input digitally into handheld personal digital assistant and synchronized to the project database. Initial data processing was performed by the field team, which included reviewing the data for integrity and completeness, and creating positioned XYZ files for each data file and QC test for use in further processing of the geophysical data. Data point positions in the raw XYZ files were in Universal Transverse Mercator coordinates in the WGS84 reference frame.

4.2.1.3.2 Preprocessing

4.2.1.3.2.1 Converted raw data files were imported into Geosoft's Oasis Montaj to perform the following:

- Review and finalize all QC tests (IVS lines, static, cable shake, personnel) prior to processing of the DGM data for that day;
- Evaluate GPS positional accuracy;
- Evaluate data density;
- Apply auto leveling and instrument drift corrections;
- Apply initial lag correction;
- Use minimum curvature gridding to produce a regular data grid of Channel 2; and,
- Generate preliminary contour map(s) from gridded data.

4.2.1.3.3 Final Processing

4.2.1.3.3.1 After completion of preprocessing, the data were further evaluated and processed to generate final processed data files. Final processing steps included:

- Evaluation and refinement of auto leveling and instrument drift corrections for all channels;
- Evaluation and refinement of lag correction;
- Additional digital filtering and enhancement, as necessary;
- Targeting of data;
- Generation of formatted American Standard Code for Information Interchange files containing processed data by dataset;
- Generation of final maps for each grid showing contoured gridded data, target locations, and physical features or cultural features that are non-MEC related items;
- Generation of final target lists for each grid;
- Generation of processing report; and,
- Creation of dig sheets for each grid.

4.2.1.3.3.2 The QC data for each survey were evaluated for compliance with requirements specified in the Work Plan and are provided in Appendix D. The results of the latency test were evaluated to determine the instrument latency correction necessary for transect data or evaluated gridded anomalies to determine the correction necessary for grids. This corrected for delays that occur in the electronics of the EM61-MK2 and in the processing of the data on the data recording computer. The latency correction was computed by determining the latency value that corrects the position to overlap the anomaly due to the latency test item when the sensor travels over it in different directions. Typically, this value was between 0.2 and 0.4 seconds.

4.2.1.3.3.3 Once the latency correction value had been determined, the value was applied to the whole data set and the geophysicist gridded the total channel data using Geosoft. The gridded channel 3 data were then displayed on a map with a color ramp to represent changing response values. The displayed values were evaluated to determine if they were consistent with the known site conditions and whether the data meet expected data quality standards.

4.2.1.3.4 Digital Geophysical Anomaly Selection

4.2.1.3.4.1 The anomaly selection process was established using data gathered with input from the USAESCH project geophysicist. The UX-Detect module within Oasis Montaj was used to identify peak amplitude responses above 3 mV in Channel 2 believed to be associated with nearby metallic sources. Initial target selections were made based on the gridded data. Data profiles corresponding to the anomalies selected using the Geosoft software package were then analyzed by trained geophysicists, with the targets evaluated as to their validity and position, as single-source anomalies may generate multiple target designations depending on shape and orientation. Targets found to be invalid or incorrectly located were removed or adjusted. Additionally, anomalies that were not selected by the UX-Detect module, yet deemed to represent a potential MEC target, were manually selected. All target selection was performed on final processed data from Channel 2 of the bottom coil of the EM61-MK2. The criteria for selecting and locating anomalies included the following:

- The maximum amplitude of the response with respect to local background conditions;
- The lateral extent (width) of the response;
- The location of the response with respect to the edge of the survey area, unsurveyable areas, land features, or cultural features within or adjacent to the survey area; and,
- The shape and amplitude of the response with respect to the response of known targets buried in the IVS.

4.2.1.3.4.2 Consistent response decay across the other three channels to flag potential noise targets (i.e., non-noise targets should exhibit channel amplitudes such that Ch1>Ch2>Ch3>Ch4.) Additional advanced processing techniques were used to calculate the decay constant and size of the anomalies. The decay constant may be used in conjunction with other advanced processing parameters to aid in selecting anomalies most likely to be produced by MEC.

4.2.1.3.4.3 Anomaly selections were merged so that closely spaced anomaly selections (peaks within 1 meter that appear to be caused by the same source item) were consolidated to a single pick. Anomalies which were known to be caused by visible metal objects (e.g., fences) were removed from the target list. The anomaly selections and the data were then evaluated by the geophysical processor to ensure that the remaining anomaly selections were reasonable. The processor added or deleted any anomaly selections as necessary.

4.2.1.3.5 Dig Sheet Development

4.2.1.3.5.1 Geophysical anomalies were identified in the EM61-MK2 data collected in the grids at the various locations during the RI field work. The project geophysicist used the anomaly selection process described previously and the prioritization process to develop dig sheets that specified the anomalies to be intrusively investigated (Appendix E). The information maintained on these dig sheet included:

- A unique anomaly identification number; northing and easting coordinates for each anomaly;
- The geophysical instrument response value from the original survey;
- The calculated decay constant for each anomaly;
- The geophysical instrument response from the reacquisition;
- The reacquisition and intrusive investigation dates; The depth of the recovered item(s);
- A description of the source of the anomaly; and,
- Other pertinent comments.

4.2.2 Intrusive Investigation

4.2.2.0.1 An intrusive investigation was conducted to resolve the source of any geophysical anomalies identified during the wide area assessment and DGM mapping within grids. The investigation was conducted by reacquiring anomaly locations that were selected for intrusive investigation and excavating the locations to identify the source of the anomaly.

4.2.2.0.2 Intrusive investigation activities were conducted by teams consisting of either a three-man team consisting of one UXO Technician III (team leader), one UXO Technician II, and one UXO Technician I; or a five-man team of one UXO Technician IIIs, two UXO Technician II's, and two UXO Technician I's. Teams reacquired anomaly locations using a RTK GPS or sub-meter accuracy Trimble GeoXT WAAS GPS units. Once anomaly locations were identified, the team excavated the area to identify the source of metal debris. Excavation of land/beach locations were conducted by UXO technicians and excavation of inland water locations were conducted by UXO divers. Once identified, debris was classified as non-MD, cultural artifacts, MD, or MEC. All MEC and MD discovered during the intrusive investigation were removed and properly disposed.

4.2.2.03 Due to the dynamic nature of the ocean surf zone, a "Mag and Dig" technique was used for ocean transects. Between 15 April and 17 June 2011, VRH performed Mag and Dig operations in the surfzone ocean areas along the eastern and northern shore of Cape Poge. Analog surveying was conducted on 26 ocean transects starting at the water's edge and extending perpendicular to the shoreline a distance of up to 600 ft seaward, which is the practical length of the diver umbilical. The dive team consisted of a dive team supervisor, a primary diver, a stand-by diver, and two dive tenders. Divers identified anomalies along transects using an underwater hand-held analog instrument, and subsequently excavated each anomaly as it was found. This methodology provided both wide area assessment and intrusive investigation to provide nature and extent data, with tape and azimuth coordinates obtained for each offshore anomaly investigated.

4.2.2.1 Anomaly Reacquisition

4.2.2.1.1 All reacquired anomalies were intrusively investigated usually on the same day that reacquisition took place. The selected geophysical anomalies were located using Trimble GeoXT sub-meter GPS units with an external antenna (see Appendix F). Anomaly locations were marked with pin flags labeled with the appropriate anomaly identification number. Pertinent information recorded during the reacquisition included the reacquisition time, date, and the grid number.

4.2.2.2 Excavation Methods

4.2.2.2.1 During the intrusive investigations conducted at the AOI, the appropriate minimum separation distances (MSD) (see below) were established per the approved Explosives Siting Plan (ESP) (USAESCH, 2010). Due to the location of the investigation sites at the AOI, there were no nonessential personnel or occupied structures within the MSDs.

4.2.2.2.2 Intrusive operations at each anomaly location were initiated by hand. The intrusive team excavated at the location of the pin flag within the search radius until the source of the anomaly was found or a no-contact was determined. If no single point within the search radius was determined to be an anomaly location (i.e., all readings remained constant), the center point of the radius was dug until the source of the anomaly was found or a no-contact was determined. A location was considered a no-contact when no specific metallic items were encountered after excavating 2 ft in depth, and no definite anomalous signal remained in the excavation. If present, the signal was pursued until a metallic item was found or until a depth of 4 ft bgs was reached. Excavation procedures at each anomaly location were conducted in accordance with the RI Work Plan (UXB, 2011).

4.2.2.3 Munitions with the Greatest Fragmentation Distance

4.2.2.3.1 The munitions with the greatest fragmentation distance (MGFD) for an area is the munitions that have the greatest fragmentation distance of any or all MEC items that are reasonably expected to be found within that area, based on research or site characterization. As presented in the DoD Explosives Safety Board (DDESB)-approved ESP, Correction 1 (USAESCH, 2010), the MGFDs for this RI was the 3-pound AN-MK23 practice bomb. The specific MGFDs for the AOI were presented in the ESP (USAESCH, 2010) and the RI Work Plan (UXB, 2011).

4.2.2.4 Minimum Separation Distance

4.2.2.4.1 The MSD is the protective distance based on the characteristics of the selected MGFD (see above). The specific MSDs for this RI were presented in the DDESB-approved ESP, Correction 1 (USAESCH, 2010) and the RI Work Plan (UXB, 2011). MSDs for unintentional detonations were established for nonessential personnel based on the hazardous fragment distance (HFD) for the appropriate MGFD. MSDs for intentional detonations were also established for disposal operations and these were based on the maximum fragmentation distance, horizontal (MFD-H) for the appropriate MGFD, though these distances could be reduced if engineering controls were used.

4.2.2.5 Exclusion Zones

4.2.2.5.1 Exclusion zones (EZs) were established during the RI to protect the public and non-essential personnel from both intentional and unintentional detonations. The primary protective distance used was the MSD for unintentional detonations, which was based on the HFD for the appropriate MGFD (see above), and these EZ distances were enforced throughout the intrusive operations at the AOI. The appropriate EZ distance for intentional detonations, which was based on the MFD-H for the appropriate MGFD modified as necessary using engineering controls (see above), was enforced during all MEC disposal operations conducted during the RI.

4.2.3 Quality Control

4.2.3.0.1 To establish confidence in the data reliability, QC tests were conducted throughout the project. Tests were conducted prior to, during, and after all data collection sessions. All QC tests for the EM61-MK2 were conducted after a minimum 15-minute warm-up period for the electronics.

4.2.3.1 Geophysical System Verification Plan

4.2.3.1.1 The geophysical system verification (GSV) plan is an alternative to traditional geophysical prove-outs (GPOs). The protocol is based on extensive physics-based modeling of instrument response to industry standard objects (ISOs) at different orientations and depths. At the AOI, four small ISOs (1 in. by 4 in. steel pipes) and one MEC surrogate item were seeded at detectable depths bgs to create an IVS.

4.2.3.1.1 Instrument Verification Strip

4.2.3.1.1.1 As an alternative to establishing a GPO, NAEVA built IVSs at the AOI. It was installed in accordance with the standard operating procedure, which was integrated in the RI Work Plan (UXB, 2011). The IVS is a seeded strip used to demonstrate the detection sensor functionality, evaluate the geologic response and geophysical data collection. Before starting field work and at any time a change is made in equipment or operator, the IVS was run to validate the overall process. All three IVSs were seeded at various depths that produced a consistent and predictable detection instrument response. The IVS locations were selected in an area that represent the terrain, vegetation, and underlying rock and/or soils that naturally exist at the site. A single line over the IVS was collected daily to ensure data quality and equipment functionality.

4.2.3.1.1.2 The IVS is an integral component of the GSV process. The purpose of surveying the IVS is to demonstrate the effectiveness of all instrumentation, methods, and personnel prior to the initiation of fieldwork and to document the site-specific capabilities of a DGM system. Serial number identifications were recorded in the database for all instrumentation (i.e. data logger, EM61-MK2 electronics, coils), and the IVS was mapped using the same personnel, equipment, and methodologies employed for the DGM survey.

4.2.3.1.1.3 A suitable area within or near the AOI yet containing similar geologic and vegetative conditions, free of interference and anomalous response, was chosen for the locations of each IVS. Prior to finalizing the IVS location, the DGM team thoroughly checked the area using the EM61-MK2 in an analog mode. Any pre-existing anomalies were marked and avoided during IVS construction. Once a suitable location was found, a background survey was performed to establish the locations of any existing anomalies, of which there were none. Following this, five items were buried according to Table 4-2. After the seeding was completed, the start and end points of the IVS line and the locations of the ISOs were recorded using a Trimble RTK GPS.

4.2.3.1.1.4 The IVS was initially mapped with five lines of data consisting of a line directly over the ISOs, a line on either side at the standard line spacing (2.5 ft), a line on one side at half line spacing (1.25 ft), and a background/noise line offset about 10 ft from the ISOs. The IVS data were used to document the repeatable responses of known objects at known depths. Daily peak responses were compared to the ideal response as documented during the initial 5-line IVS. Subsequent runs of the IVS recorded data directly over the ISOs and along the background line.

Table 4-2. Cape Poge IVS Design
Former Cape Poge Little Neck Bomb Target Area of Investigation

Item	Easting (meters)	Northing (meters)	Depth (to center of mass) (centimeters)	Item Size	Orientation
1	378985.677	4584291.368	8	Small Industry Standard Objective	Vertical
2	378980.746	4584291.435	15	Small Industry Standard Objective	Vertical
3	378975.580	4584291.244	37	Small Industry Standard Objective	Vertical
4	378970.743	4584291.513	14	Small Industry Standard Objective	Vertical
5	378965.878	4584291.549	8	Munitions and Explosives of Concern Surrogate	Vertical

4.2.3.1.2 Blind Seeding

4.2.3.1.2.1 The blind seeding portion of the GSV was conducted and evaluated by UXB. Seed items were emplaced at varying depths throughout the gridded area of collection, so that at least one seed item would be surveyed each day. The locations of these items were not provided to NAEVA. The UXB Geophysicist evaluated the data delivered by NAEVA and did not report a failure to detect or target any of the blind seeds.

Table 4-3. Summary of Blind Seeding Activities
Former Cape Poge Little Neck Bomb Target Area of Investigation

Grid ID	Seed ID	Easting	Northing	Recovered	DGM Target ID	EM61Signal CH1_Final	EM61Signal CH2_Final	EM61Signal CH3_Final	EM61Signal CH4_Final
P0004	13	378700.9	4586469.36	Y	0002	67.9075645	43.108833	22.934331	10.1180712
P0008	22	378355.4	4585595.7	Y	0002	119.581703	81.136002	47.342155	22.4677944
P0011	17	378880.1	4585378.96	Y	0004	106.700656	79.171814	48.491977	25.4839833
P0012	28	378896.9	4585287.12	Y	0002	57.3500679	36.397663	18.477332	7.27987079
P0018	23	378687.3	4585103.25	Y	0001	144.192703	105.13803	62.151436	30.0258808
P0019	29	378677	4585292.29	Y	0001	134.460888	86.456935	46.220958	18.7256465

4.2.3.2 Instrument/Equipment Testing

4.2.3.2..0.1 The following QC procedures were performed and documented during the data collection process and reviewed by a qualified geophysicist on a daily basis.

4.2.3.2.1 Geonics® EM61-MK2

4.2.3.2.1.1 Each day of data collection, the instrument was powered-on for a warm-up period of at least 15 minutes to stabilize readings and minimize instrument drift. After warm-up, a series of 60-second static QC tests were performed with the instrument immobilized over an area of minimal background response in order to document proper instrument function. These tests were also performed at the end of each day. While checking instrument performance, the static background test also documents local site noise levels. The instrument operator monitored the response during the tests for abnormal behavior. During data processing, the tests were further analyzed quantitatively.

4.2.3.2.1.2 All digital geophysical data was acquired such that 98 percent of along-track sampling does not exceed 0.25 m. For grids, at least 90 percent of the across-track sampling was equal to the proposed 2.5 ft line spacing. QC procedures were performed and documented during the data collection process and reviewed by a qualified geophysicist on a daily basis. The standard of performance adhered to the most recent USACE performance requirements for RI/FS using DGM methods. Static and dynamic repeatability for both detection and positioning systems, geodetic accuracy, coverage, target selections, and anomaly resolution was consistently monitored at appropriate frequencies to ensure that all requirements and DQOs were achieved.

Personnel Test

4.2.3.2.1.3 While logging the data, the operator looked for changes in response associated with personnel in proximity to the instrument coil. Support personnel not actively operating the instrument generally do not approach the coil during production surveys. This test is designed to confirm that the instrument operator, who is closest to the coil during logging, does not interfere with the data. Common sources of operator interference include metal items in pockets and steel-toed boots.

Cable Shake Test

4.2.3.2.1.4 In the cable shake test, all system cables are shaken while logging and monitoring for data spikes. This test functions to detect problems associated with damaged or loose connectors, damaged cables, and other defects. Replacing the offending component usually resolves problems in this test.

Background/Spike Test

4.2.3.2.1.5 Performed at the beginning and end of each day, the background/spike test consists of three 60-second lines of data: background, ISO/spike, and background. Background lines are monitored for data spikes and noise level while the spike line is examined for consistent response. Monitoring background noise enables the Geophysical Data Processor to calibrate data leveling during processing. For the spike test, a small ISO is approximately centered above the EM61-MK2 coil. During the DGM survey, an item height of 50 cm was initially used, but was later changed to 43 cm. Daily spike response values were plotted against the small ISO response curve at the given depth. The acceptance criterion for the spike response was ±20 percent of the expected response according to the NRL response curve (13.35 mV and 22.4 mV in Channel 2); static tests were also plotted on a scale of ±2 mV so that any abnormally high data spikes could be observed.

Repeat Data

4.2.3.2.1.6 After completion of each dataset, approximately 2 percent of the data were recollected in a separate file to demonstrate instrument consistency and data integrity throughout the course of the survey. Repeat data also serves to evaluate and validate the particular collection and positioning methods. Evaluation of repeat data was conducted qualitatively against original data profiles.

4.2.3.2.2 Trimble 5700 RTK GPS System

4.2.3.2.2.1 At the beginning of the day, and after setting up the base station and before collecting any data, the GPS antenna was mounted on a survey pole and placed at a known point to check the accuracy. The reported position was compared to the known position to check for proper base station and rover operation. The locations were stored in Trimble Survey Controller and input into the PDA for inclusion in the project database. Positional discrepancies within 10 cm were considered acceptable.

4.2.3.3 Data Processing and Database Quality Control

4.2.3.3.1 New field data (XML files) were imported into the database and were checked to make sure that all the field notes were formatted and filled in correctly. Dataset identification and grid identification were verified as unique with no duplicated information. Line paths plotted to be sure that all the grids associated with a dataset were present in the database and that any missing grid identifications were updated. The actual acreage of data collection was calculated and was updated in the database.

4.2.3.3.2 Raw field reports were printed and checked to confirm they contained all the proper information, including grid identification, sketch maps, and field notes. At the end of processing a dataset, processing reports were generated from the project database, which list down-line data density statistics, GPS quality, leveling, lag, and gridding parameters used in processing each dataset, as well as a list of all associated file names and supporting QC test results. Suspected culture or noise targets were identified in the comments field of the target lists. Processors examined all data prior to NAEVA demobilizing from the site.

4.2.3.3.3 The hand held analog instruments used for instrument-aided reconnaissance and anomaly avoidance were checked at the start and end of each day by operating the instrument over a test plot seeded with metallic test items. The instruments were considered functional if the items could be detected. The instrument was also shaken to check for loose parts and bad electrical connections. The instrument checks were recorded in the field log book. No deficiencies in the operation of the Schonstedt magnetometers were noted.

4.2.3.4 Intrusive Investigation Quality Control

4.2.3.4.1 Each anomaly was intrusively investigated and characterized by the intrusive team. For location data, the daily GPS QC Check was documented in the team's logbook (see Appendix E). The intrusive team leader documented the source of the anomaly, and verified that the anomaly had been adequately characterized. A final reading was taken with the EM61-MK2 at the anomaly location to confirm that the area had been cleared. Any remaining response at an anomaly location was investigated unless the source of the response could be attributed to an anomaly greater than 3 ft from the original peak. In addition to the post-intrusive checks by the dig teams, the site geophysicist reviewed the dig results and compared what was found by the intrusive teams with the geophysical anomalies selected from the DGM data.

4.2.4 Munitions Management

4.2.4.1 MEC Storage

4.2.4.1.1 In accordance with the ESP (USAESCH, 2010), a collection point was established within the work area for the storage of MEC items for same-day consolidated shots if items were acceptable to move; any items not deemed acceptable to move were demolished using blow-in-place (BIP) procedures. All MEC items were demolished the day they were found; in the event demolition was not practical due to items found late in the day, weather, etc., a guard was posted until demolition took place the next day. MD items recovered during the project were stored in a locked container, with access controlled by the Senior Unexploded Ordnance Supervisor (SUXOS) and Unexploded Ordnance Safety Officer (UXOSO).

4.2.4.2 MEC Disposal

4.2.4.2.1 An account of recovered MPPEH, MEC, or MD items, including photographs, was maintained during the RI. Each piece of recovered MEC or MPPEH was given a unique database identification number, and the item was tracked from discovery to final disposition. All MEC items discovered during this project either were disposed of through BIP or consolidated shots the day they were discovered, and the date of demolition was recorded. Any MEC/MPPEH not disposed of on the day of discovery was guarded until it could be disposed of the next day. The SUXOS was responsible for the tracking and maintenance of all ordnance recovered during the project. Demolition activity summation tables are included in Appendix G.

4.2.4.3 Inspection of Material Potentially Presenting an Explosive Hazard

4.2.4.3.1 MPPEH items observed during intrusive operations were evaluated by the SUXOS and the UXOSO. Items confirmed or suspected to be MEC were either BIP or, if they were determined to be acceptable-to-move by the SUXOS and USOSO, and with the concurrence of OESS, the item(s) were consolidated for demolition per DDESB approved consolidated shot method. Once demolition operations were complete, the SUXOS certified the explosively vented items and any remaining MPPEH were free of explosive hazards. This condition was verified by the UXOSO or Unexploded Ordnance Quality Control Specialist (UXOQCS). Once the MPPEH was determined to be free of explosive hazards, the SUXOS certified and signed, and the UXOSO/UXOQCS verified and signed the DD Form 1348-1A (Appendix H) to certify the material as MD. After inspection and certification, the recovered MD items were placed in the locked storage container at the secure storage area until appropriate disposition was arranged at the conclusion of each field season.

4.3 MC Characterization

4.3.0.1 The following subsections provide a description of the environmental sampling activities performed at the site in order to characterize MCs. This includes all field activities, duration and procedures for collecting samples and data, and variations from the work plan.

4.3.1 Field Activities and Methodologies

4.3.1.1 Between 13 October and 2 November 2011, environmental sampling for MCs was conducted at the AOI. All field activities were documented in a field log, which is included in Appendix E. A photograph log of MC sampling activities is included in Appendix I. The procedures and methodologies for field investigation activities followed those outlined in the RI Work Plan (UXB, 2011). Any deviations from these plans and sampling rationale are discussed in Section 4.3.2.

4.3.1.2 Table 4-4 provides a summary of the MCs that were potentially released at the site. All samples collected during this investigation (i.e., soil, sediment, and groundwater) were analyzed for these MCs.

Table 4-4. Summary of Munitions Constituents
Former Cape Poge Little Neck Bomb Target Area of Investigation

Constituent	CAS Number*	Synonym/ Abbreviation	Description*
Metals			
Antimony	7440-36-0	--	Alloy used as a hardening agent
Copper	7440-50-8	--	Bomb casing alloy metal
Lead	7439-92-1	--	Bomb casing alloy metal
Nickel	7440-02-0	--	Bomb casing alloy metal
Zinc	7440-66-6	--	Bomb casing alloy metal
Explosives Compounds			
1,3,5-Dinitrotoluene	99-35-4	1,3,5-DNT	TNT co-contaminant and breakdown product
1,3-Dinitrotoluene	99-65-0	1,3-DNT	DNT breakdown product and TNT co-contaminant
2,4,6-Trinitrotoluene	118-96-7	2,4,6-TNT	Nitroaromatic explosive.
2,4-Dinitrotoluene	121-14-2	2,4-DNT	Nitroaromatic explosive/ propellant; also TNT co-contaminant
2,6-Dinitrotoluene	606-20-2	2,6-DNT	Nitroaromatic explosive/ propellant; also TNT co-contaminant
2-Amino-4,6-Dinitrotoluene	355-72-78-2	--	TNT breakdown product
2-Nitrotoluene	88-72-2	--	DNT co-contaminant
3-Nitrotoluene	99-08-1	--	DNT co-contaminant
4-Amino-2,6-Dinitrotoluene	1946-51-0	--	TNT breakdown product
4-Nitrotoluene	99-99-0	--	DNT co-contaminant
Octahydro-1, 3, 5, 7-tetranitro-1,3,5,7-tetrazocine	2691-41-0	HMX	Nitramine explosive; also RDX co-contaminant[a]

Table 4-4. Summary of Munitions Constituents (continued)
Former Cape Poge Little Neck Bomb Target Area of Investigation

Constituent	CAS Number*	Synonym/ Abbreviation	Description*
Nitrobenzene	98-95-3	--	DNT co-contaminant
Nitroglycerin	55-63-0	NG	Nitrate ester explosive/propellant
Pentaerythritol tetranitrate	78-11-5	PETN	Nitrate ester explosive
Hexahydro-1,3,5-trinitro-1,3,5-triazine	121-82-4	RDX	Nitramine explosive; also HMX co-contaminant[a]
Methyl-2,4,6-trinitrophenylnitramine	479-45-8	Tetryl	Nitramine explosive

*Information gathered from ATSDR Toxicological Profiles (located at http://www.atsdr.cdc.gov/toxprofiles/) and the Hazardous Substances Data Bank (located at http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB).

[a] RDX contains approximately 10 % HMX which is an impurity formed during the synthesis of RDX.

4.3.1.1 Soil Investigation

4.3.1.1.1 Between 16 October and 18 October 2011, 3 incremental soil (0 to 2 in. bgs), 24 discrete surface soil (2 to 12 in. bgs), and 23 discrete subsurface soil (12 to 18 in. bgs) samples were collected at the site (Figure 4-2). QC samples were collected at every incremental soil sample location and at 10 percent of discrete soil sample locations, resulting in 6 incremental field triplicate samples, 2 duplicate surface soil samples, and 2 duplicate subsurface soil samples. Soil sample locations were biased toward areas where the geophysical/intrusive investigation identified high concentrations of MEC and MD.

4.3.1.1.2 Incremental soil samples were collected at three locations at Little Neck (CP01, CP02, and CP03) in areas with high anomaly density found during the intrusive investigation (Figure 4-2). The dimensions of each incremental sample unit, varied based on historical data and the results of the geophysical/intrusive investigation and were as follows:

- Sample Unit CP01 measured 28 ft by 350 ft with grids that were 7 ft by 14 ft;
- Sample Unit CP02 measured 24 ft by 250 ft with grids that were 6 ft by 10 ft; and,
- Sample Unit CP03 measured 50 ft by 50 ft with grids that were 5 ft by 5 ft.

Soil sampling activities were implemented in a phased approach to: 1) determine if soil had been impacted; and, 2) determine the extent of impacts to soil if identified. Incremental samples of the top 2 inches were collected from areas with high anomaly density found during the intrusive investigation. Discrete, biased, surface samples were collected in areas of identified MEC. Discrete, biased subsurface samples were collected within the IS sampling units or directly under the discrete surface soil samples to determine vertical extent.

4.3.1.1.3 The four corners of each sample unit were recorded using a GPS unit capable of sub-meter accuracy. To determine a statistically random starting point, a GIS tool was used to select a random point location in a corner grid of each sample unit. When using this tool, the spatial extents of the corner grid were used to constrain the acceptable locations in which the point could be placed. Using a random number generator function, the tool chose a random x, y coordinate pair that had a location within the constraining extent. An increment was then collected at the same relative location in each sample unit grid.

4.3.1.1.4 Within each sample unit, one increment was collected from each grid for a total of 100 increments. Each increment was collected at a depth ranging from 0 to 2 in. bgs using a soil coring tool in the same relative location within each grid. Field triplicates were collected within each of the sample units at the site also using a random number generator, collected in a similar fashion to the first IS. Stainless steel sampling tools were used to collect and homogenize the incremental samples. All samples were placed in a new, clean gal-size polyethylene bag, which was sealed, labeled, and taped closed prior to shipment to the contracted laboratory.

4.3.1.1.5 Additional soil samples were collected as discrete, biased soil samples collected at locations where MEC had been identified. Discrete samples were collected within the incremental sampling units in an effort to collect native soil and determine vertical extent. These samples were collected and homogenized using stainless steel tools and placed in the containers provided by the laboratory.

4.3.1.1.6 All soil samples were collected in accordance with the MC Sampling and Analysis Plan (UXB, 2011). A sample collection log documenting surface soil sample collection is included as Appendix E. Table 4-4 provides a summary of the soil samples collected at the site.

Table 4-5. Soil Sample Summary
Former Cape Poge Little Neck Bomb Target Area of Investigation

Station ID	Sample ID	Sample Date	Sample Type	Matrix	Depth (inches)	Rationale
CP01	IS01	10/16/11	Incremental Sample (IS)	Surface Soil	0-2	Sampling unit covered the length of the western portion of the former target area, where high density anomalies were found during the intrusive investigation.
CP01	IS02	10/16/11	IS Duplicate	Surface Soil	0-2	Duplicate IS to determine percent relative standard deviation (%RSD).
CP01	IS03	10/16/11	IS Triplicate	Surface Soil	0-2	Triplicate IS to determine %RSD.
CP02	IS004	10/17/11	IS	Surface Soil	0-2	Sampling unit covered the length of the southwestern portion of the former target area, where high density anomalies were found during the intrusive investigation.
CP02	IS005	10/17/11	IS Duplicate	Surface Soil	0-2	Duplicate IS to determine %RSD.

Table 4-5. Soil Sample Summary (continued)

Former Cape Poge Little Neck Bomb Target Area of Investigation

Station ID	Sample ID	Sample Date	Sample Type	Matrix	Depth (inches)	Rationale
CP02	IS006	10/17/11	IS Triplicate	Surface Soil	0-2	Triplicate IS to determine %RSD.
CP03	IS007	10/18/11	IS	Surface Soil	0-2	Sampling unit will cover area of high density anomalies found during the intrusive investigation.
CP03	IS008	10/18/11	IS Duplicate	Surface Soil	0-2	Duplicate IS to determine %RSD.
CP03	IS009	10/18/11	IS Triplicate	Surface Soil	0-2	Triplicate IS to determine %RSD.
CP04	SB001	10/16/11	Discrete	Surface Soil	2-12	Discrete sample collected from high density anomaly area near target.
CP04	SB002	10/16/11	Discrete	Subsurface Soil	12-18	Discrete sample collected from high density anomaly area near target.
CP05	SB003	10/16/11	Discrete	Surface Soil	2-12	Discrete sample collected from high density anomaly area near target.
CP05	SB004	10/16/11	Discrete	Subsurface Soil	12-18	Discrete sample collected from high density anomaly area near target.
CP06	SB005	10/16/11	Discrete	Surface Soil	2-12	Discrete sample collected from high density anomaly area near target.
CP06	SB006	10/16/11	Discrete	Subsurface Soil	12-18	Discrete sample collected from high density anomaly area near target.
CP07	SB007	10/16/11	Discrete	Surface Soil	2-12	Discrete sample collected from high density anomaly area near target.
CP07	SB008	10/16/11	Discrete	Subsurface Soil	12-18	Discrete sample collected from high density anomaly area near target.
CP08	SB009	10/16/11	Discrete	Surface Soil	2-12	Discrete sample collected from high density anomaly area near target.
CP08	SB010	10/16/11	Discrete	Subsurface Soil	12-18	Discrete sample collected from high density anomaly area near target.
CP08	SB011	10/16/11	Discrete Duplicate	Subsurface Soil	12-18	Discrete sample in west-central portion of Little Neck
CP09	SB012	10/16/11	Discrete	Surface Soil	2-12	Discrete sample collected from high density anomaly area near target.
CP09	SB013	10/16/11	Discrete	Subsurface Soil	12-18	Discrete sample collected from high density anomaly area near target.
CP10	SB014	10/16/11	Discrete	Surface Soil	2-12	Discrete sample collected from high density anomaly area near target.

Table 4-5. Soil Sample Summary (continued)

Former Cape Poge Little Neck Bomb Target Area of Investigation

Station ID	Sample ID	Sample Date	Sample Type	Matrix	Depth (inches)	Rationale
CP10	SB015	10/16/11	Discrete	Subsurface Soil	12-18	Discrete sample collected from high density anomaly area near target.
CP11	SB16A	10/16/11	Discrete	Surface Soil	2-12	Discrete sample collected from high density anomaly area near target.
CP11	SB16B	10/16/11	Discrete	Subsurface Soil	12-18	Discrete sample collected from high density anomaly area near target.
CP12	SB017	10/16/11	Discrete	Surface Soil	2-12	Discrete sample collected from high density anomaly area near target.
CP12	SB018	10/16/11	Discrete	Subsurface Soil	12-18	Discrete sample collected from high density anomaly area near target.
CP13	SB019	10/17/11	Discrete	Surface Soil	2-12	Discrete sample collected from high density anomaly area near target.
CP13	SB020	10/17/11	Discrete	Subsurface Soil	12-18	Discrete sample collected from high density anomaly area near target.
CP13	SB021	10/17/11	Discrete Duplicate	Surface Soil	2-12	Duplicate sample
CP14	SB023	10/17/11	Discrete	Surface Soil	2-12	Discrete sample collected from high density anomaly area near target.
CP14	SB024	10/17/11	Discrete	Subsurface Soil	12-18	Discrete sample collected from high density anomaly area near target.
CP15	SB025	10/17/11	Discrete	Surface Soil	2-12	Discrete sample collected from high density anomaly area near target.
CP15	SB026	10/17/11	Discrete	Subsurface Soil	12-18	Discrete sample collected from high density anomaly area near target.
CP16	SB027	10/17/11	Discrete	Surface Soil	2-12	Discrete sample collected from high density anomaly area near target.
CP16	SB028	10/17/11	Discrete	Subsurface Soil	12-18	Discrete sample collected from high density anomaly area near target.
CP17	SB029	10/17/11	Discrete	Surface Soil	2-12	Discrete sample collected from high density anomaly area near target.
CP17	SB030	10/17/11	Discrete	Subsurface Soil	12-18	Discrete sample collected from high density anomaly area near target.
CP18	SB031	10/17/11	Discrete	Surface Soil	2-12	Discrete sample collected from high density anomaly area near target.
CP18	SB032	10/17/11	Discrete	Subsurface Soil	12-18	Discrete sample collected from high density anomaly area near target.

Table 4-5. Soil Sample Summary (continued)
Former Cape Poge Little Neck Bomb Target Area of Investigation

Station ID	Sample ID	Sample Date	Sample Type	Matrix	Depth (inches)	Rationale
CP18	SB033	10/17/11	Discrete Duplicate	Subsurface Soil	12-18	Duplicate sample
CP19	SB034	10/17/11	Discrete	Surface Soil	2-12	Discrete sample collected from high density anomaly area near target.
CP19	SB035	10/17/11	Discrete	Subsurface Soil	12-18	Discrete sample collected from high density anomaly area near target.
CP20	SB036	10/18/11	Discrete	Subsurface Soil	12-18	Discrete sample collected from high density anomaly area near target.
CP20	SB037	10/18/11	Discrete	Surface Soil	2-12	Discrete sample collected from high density anomaly area near target.
CP21	SB038	10/18/11	Discrete	Surface Soil	2-12	Discrete sample collected from high density anomaly area near target.
CP21	SB039	10/18/11	Discrete	Subsurface Soil	12-18	Discrete sample collected from high density anomaly area near target.
CP22	SB040	10/18/11	Discrete	Surface Soil	2-12	Discrete sample collected from high density anomaly area near target.
CP22	SB041	10/18/11	Discrete	Subsurface Soil	12-18	Discrete sample collected from high density anomaly area near target.
CP23	SB042	10/18/11	Discrete	Surface Soil	2-12	Discrete sample collected from high density anomaly area near target.
CP23	SB043	10/18/11	Discrete	Subsurface Soil	12-18	Discrete sample collected from high density anomaly area near target.
CP23	SB044	10/18/11	Discrete Duplicate	Surface Soil	2-12	Duplicate sample
CP24	SB046	10/18/11	Discrete	Surface Soil	2-12	Discrete sample collected from high density anomaly area near target.
CP24	SB047	10/18/11	Discrete	Subsurface Soil	12-18	Discrete sample collected from high density anomaly area near target.
CP25	SB048	10/18/11	Discrete	Surface Soil	2-12	Discrete sample collected from high density anomaly area near target.
CP25	SB049	10/18/11	Discrete	Subsurface Soil	12-18	Discrete sample collected from high density anomaly area near target.
CP26	SB050	10/18/11	Discrete	Surface Soil	2-12	Discrete sample collected from high density anomaly area near target.

Table 4-5. Soil Sample Summary (continued)

Former Cape Poge Little Neck Bomb Target Area of Investigation

Station ID	Sample ID	Sample Date	Sample Type	Matrix	Depth (inches)	Rationale
CP26	SB051	10/18/11	Discrete	Subsurface Soil	12-18	Discrete sample collected from high density anomaly area near target.
CP27	SB052	10/18/11	Discrete	Surface Soil	2-12	Discrete sample collected from high density anomaly area near target.
CP27	SB053	10/18/11	Discrete	Subsurface Soil	12-18	Discrete sample collected from high density anomaly area near target.

Notes:
IS – incremental sample
%RSD – percent relative standard deviation

4.3.1.2 Sediment Investigation

4.3.1.2.1 Between 19 October and 1 November 2011, 16 discrete sediment samples (0 to 6 in. bgs) were collected at the AOI (Figure 4-2). QC samples were collected at 10 percent of discrete sediment sample locations resulting in 1 duplicate sediment soil sample. Sediment samples were collected as discrete samples biased toward areas where the intrusive investigation identified high concentrations of MEC and MD. Samples were collected using a petite ponar dredge sampler. Sediment sample locations are shown on Figure 4-2. A sample collection log documenting sediment sample collection is included as Appendix E. Table 4-5 provides a summary of the sediment samples collected at the site.

Table 4-6. Sediment Sample Summary
Former Cape Poge Little Neck Bomb Target Area of Investigation

Station ID	Sample ID	Sample Date	Sample Type	Matrix	Depth (inches)	Location
CP32	SD001	10/22/11	Discrete	Sediment	0-6	Sample collected from biologically active zone within intrusive grid in south-central portion of Shear Pen Pond.
CP33	SD002	10/22/11	Discrete	Sediment	0-6	Sample collected from biologically active zone within intrusive grid northwest of Little Neck
CP34	SD003	10/22/11	Discrete	Sediment	0-6	Sample collected from biologically active zone within intrusive grid northwest of Little Neck

Table 4-6. Sediment Sample Summary (continued)

Former Cape Poge Little Neck Bomb Target Area of Investigation

Station ID	Sample ID	Sample Date	Sample Type	Matrix	Depth (inches)	Location
CP35	SD004	10/22/11	Discrete	Sediment	0-6	Sample collected from biologically active zone within intrusive grid northwest of Little Neck
CP36	SD005	10/22/11	Discrete	Sediment	0-6	Sample collected from biologically active zone within intrusive grid west of Little Neck
CP37	SD006	10/22/11	Discrete	Sediment	0-6	Sample collected from biologically active zone within intrusive grid west of Little Neck
CP38	SD007	10/22/11	Discrete	Sediment	0-6	Sample collected from biologically active zone within intrusive grid west of Little Neck
CP39	SD008	10/22/11	Discrete	Sediment	0-6	Sample collected from biologically active zone within intrusive grid southwest of Little Neck
CP40	SD009	10/22/11	Discrete	Sediment	0-6	Sample collected from biologically active zone within intrusive grid southwest of Little Neck
CP41	SD010	10/22/11	Discrete	Sediment	0-6	Sample collected from biologically active zone within intrusive grid southwest of Little Neck
CP41	SD011	10/22/11	Discrete Duplicate	Sediment	0-6	Duplicate sample
CP42	SD012	10/22/11	Discrete	Sediment	0-6	Sample collected in a known clamming area within Drunkards Cove
CP43	SD013	10/22/11	Discrete	Sediment	0-6	Sample collected in a known clamming area within Drunkards Cove within Drunkards Cove
CP44	SD014	11/1/11	Discrete	Sediment	0-12	Sample collected in a known clamming area within surface water body between Little Neck and Atlantic Ocean
CP45	SD015	11/1/11	Discrete	Sediment	0-12	Sample collected in a known clamming area within surface water body between Little Neck and Atlantic Ocean
CP45	SD016	11/1/11	Discrete Duplicate	Sediment	0-12	Sample collected in a known clamming area within surface water body between Little Neck and Atlantic Ocean
CP46	SD017	11/1/11	Discrete	Sediment	0-12	Sample collected in a known clamming area within surface water body between Little Neck and Atlantic Ocean

4.3.1.3 Groundwater Investigation

4.3.1.3.1 On 1 November 2011, three groundwater samples and one duplicate sample were collected at the site (Figure 4-2). Tidewater, Inc. provided drilling services using a remote controlled Geoprobe® drill rig using the small diameter driven well sample collection method (MADEP, 1999). Groundwater samples were collected to characterize the groundwater within the AOI and to determine whether historical military activities have affected groundwater quality. No monitoring wells were installed during this RI. Due to the lack of a freshwater aquifer, groundwater samples were not collected at Little Neck (proposed location CP28 GW001) and at proposed sample location CP30 GW003 located in the southwestern portion of Cape Poge. Additionally, one groundwater sample (CP47 GW015), which was located at a public access well adjacent to the lighthouse, was added to the sampling plan based on public access to the well.

4.3.1.3.2 Groundwater samples were collected using a peristaltic pump and low flow sampling techniques. A sample was collected after stabilization of field measurements; including, temperature, specific conductance, dissolved oxygen, oxidation reduction potential, salinity, and turbidity. The laboratory provided sample containers were filled directly through an inline 0.45 micro (µ) filter connected to tubing. Groundwater sample locations are shown on Figure 4-2. A sample collection log documenting groundwater sample collection is included as Appendix E. Table 4-6 provides a summary of the groundwater samples collected at the site.

Table 4-7. Groundwater Sample Summary
Former Cape Poge Little Neck Bomb Target Area of Investigation

Station ID	Sample ID	Sample Date	Sample Type	Matrix	Depth (feet)	Location
CP29	GW002	11/1/11	Regular	Groundwater	28-32	Grab sample collected near residence in northeast portion of Area of Investigation.
CP31	GW004	11/1/11	Regular	Groundwater	8-12	Grab sample collected near residence in northeast portion of Area of Investigation.
CP31	GW005	11/1/11	Duplicate	Groundwater	8-12	Duplicate Sample
CP47	GW015	11/1/11	Regular	Groundwater	27-32	Grab sample in northeastern portion of Cape Poge (adjacent to lighthouse)

4.3.2 Variations from the Work Plan

4.3.2.1 The sampling procedures and analytical protocol presented in the RI Work Plan (UXB, 2011) were followed; however, deviations did occur based on the issues presented below:

- Due to the lack of a freshwater aquifer, a groundwater sample was not collected at Little Neck (CP28 GW001) or at proposed sample location CP30 GW003; and,
- One groundwater sample (CP47 GW015) located adjacent to the lighthouse at Cape Poge was added to the sampling plan based on public access to the well.

4.3.3 Sample Procedures and Analysis

4.3.3.1 Chemical analysis of environmental samples collected at the AOI were conducted by TestAmerica, Inc. (TestAmerica) located in Arvada, Colorado, a DoD Environmental Laboratory Accreditation Program certified lab. COCs for samples sent to TestAmerica are included in Appendix E. Analytical procedures followed Method 3050/6020A for discrete soil and sediment metals analysis, Method 8321B for discrete soil and sediment explosives analysis, Method 8330B (prep only, no grinding)/6020A for metals IS analysis, Method 8330B (prep only)/8321B for explosives IS analysis, Method 3050/6020A for metals analysis of groundwater, and Method 3535A/8321B for explosives analysis of groundwater.

4.3.4 Data Validation

4.3.4.1 One-hundred percent of the MC data was validated according to the DoD QSM Version 4.2 and verified by the USAESCH using ADR software. Data quality was evaluated against the DQOs established in the RI Work Plan (UXB, 2011).

4.3.4.2 A presentation of various field and laboratory quality assurance (QA)/QC criteria used to evaluate data quality and results of the data quality evaluation process are included in the Data Validation Report (Appendix D). Based on the Data Quality Indicators (precision, accuracy, representativeness, comparability, and completeness), the data quality for the site was evaluated and determined to be usable for the evaluation of the nature and extent of contamination and for use in evaluating potential effects of existing site conditions on human health. Data were qualified as discussed in the Data Validation Report (Appendix D). Qualified data are usable with the limitations described. Results of data quality evaluation are summarized as follows:

- Accuracy and Precision goals were met;
- Project Representativeness goals were achieved;
- Samples collected during the RI generated Analytical Level III data, which allows for adequate comparability to past and future investigations; and,
- Laboratory completeness was 100 percent, and field completeness was 98 percent.

4.3.5 Investigation Derived Waste

4.3.5.1 Less than 10 gallons of investigation derived waste (IDW) was generated during equipment decontamination activities and low flow groundwater purging. A waste characterization sample (MV01 IDW01) was collected on 3 November 2011 and analyzed at TestAmerica Denver. The IDW was transported to and disposed at the Edgartown Wastewater Treatment Facility (Appendix H).

5.0 REVISED CONCEPTUAL SITE MODEL AND RI RESULTS

5.0.1 Results from the MEC and MC investigations have been evaluated and used to update the pre-investigation CSM discussed in Section 3.1.

5.1 MEC Investigation Results

5.1.1 AirMag Results

5.1.1.1 Within the AOI, 2,447 anomalies were identified above the threshold value presented in Figure 5-1. A full description of the Battelle VG-22 system, the field operations, and the findings of the AirMag survey are presented in Appendix A and summarized in Table 5-1.

Table 5-1. AirMag Summary Table
Former Cape Poge Little Neck Bomb Target Area of Investigation

Site	Size	Mean Altitude	Total Number of Anomalies	Number of Anomalies Picked	Collection Dates	Number of Reflights Lines
Cape Poge	347 acres	2.49 meters	2447	Priority 1 = 782 Priority 2 = 550 Priority 3 = 1115	2/11/11, 2/16/11, 2/17/11	0

5.1.2 Analog Results

5.1.2.1 The objective of the analog transect surveys to locate areas of elevated concentrations of geophysical anomalies that could represent potential historical military target areas or areas impacted with MEC or MD was achieved as shown in Figure 5-2. High densities of anomalies were confirmed in the western portion of Little Neck corresponding to the historic target area. MEC and MD were observed along transects located in and around the Little Neck historic target.

5.1.2.2 Although high density anomalies were observed in the residential area north of Shear Pen Pond, these areas correspond with residences where non-MD items (metallic debris) were observed on the surface. No MEC or MD was observed along transects located in the residential area north of Shear Pen Pond. Therefore, the high density anomaly areas do not represent historic target areas.

5.1.3 Digital Geophysical Mapping Results

5.1.3.1 DGM data were collected within transects and grids over 2.1 acres of land, beach and inland water areas of the AOI.

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FIGURE 5-1

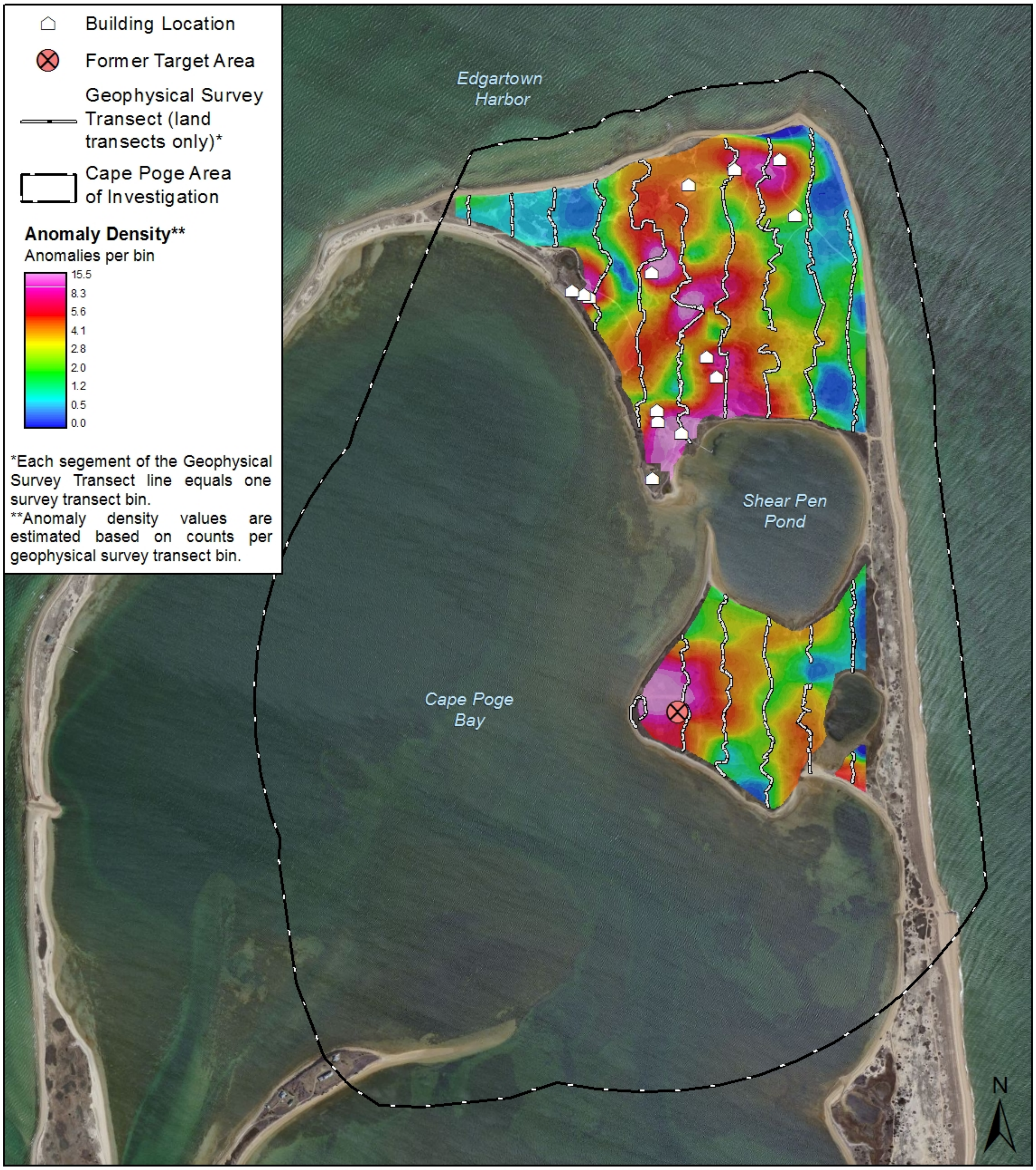
Air Magnetometer Results
Former Cape Poge Little Neck Bomb Target Site Area of Investigation
Martha's Vineyard, MA

0 150 300 600 900 Meters
0 500 1,000 2,000 3,000 Feet

UXB amec

NOTES:
2011 Aerial Data Source: Bing Maps, Microsoft Corp.

05/04/2012	Rev:	CPoge_Air_Mag_Results_Remedial_Inv_Rpt.mxd
Drawn: JBO	Chk: DMS	PROJ: 562910000



*Each segement of the Geophysical Survey Transect line equals one survey transect bin.
**Anomaly density values are estimated based on counts per geophysical survey transect bin.

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FIGURE 5-2
Land Analog Transect Results - Former Cape Poge Little Neck Bomb Target Area of Investigation, Martha's Vineyard, MA

0 100 200 400 600 800 Meters
0 1,000 2,000 3,000 Feet

NOTES:
2011 Aerial Data Source: Bing Maps, Microsoft Corp.

05/01/2012	Rev:	CPoge_Land_Results_Remedial_Inv_Rpt.mxd
Drawn: JBO	Chk: DMS	PROJ: 562910000

Transects:

5.1.3.2 The objective was to locate elevated areas of geophysical anomalies that could represent MEC or MD. DGM data were collected along six transects covering 2.1 acres at the AOI resulting in a total of 120 anomalies identified above the targeting threshold of 3 mV in Channel 2.

Grids:

5.1.3.3 The placement of Grids was decided by the density of anomalies found along the analog transects as well as targets of interest located on beach transects and AirMag data. Grids were placed in areas of high, medium, and low density anomalies. A total of thirty-two 50 ft by 50 ft grids and five 100 ft by 100 ft grids covering 3.02 acres were mapped resulting in 827 targets.

5.1.3.4 Many of the grids along the dunes and beach on the eastern side of the AOI contained very few anomalies. Mostly what was observed on the surface of these grids contained either exposed remnants of fences or debris that had washed ashore. Further north in grid P0004 was what looked to be the remains of a building that had fallen off a cliff when erosion had undercut it. Exposed were sections of a brick wall lying flat on the beach. Most of the other grids to the north contained exposed metallic debris such as pipes and unidentifiable corroded chunks of metal most likely related to the properties near these grids.

5.1.3.5 Grid P0027 (100-ft by 100-ft grid) and P0026, P0028 (50-ft by 50-ft grids) had the highest target density of any of the grids within the AOI. Combined they contained 354 anomalies which would equate to 1,041 targets per acre. The density in these grids along with the anomaly distribution in grids P0023 (density greater to the north) and P0024 (density slightly greater to the south) make this consistent with the Former Cape Poge Little Neck Bombing Target. Several pieces of munitions related debris were found on the surface of these grids.

5.1.4 Intrusive Investigation Results

5.1.4.1 During intrusive investigation activities, 88 MEC and 325 items of MD were recovered from land, beach, and inland water areas. These items included intact and expended AN-MK23 3-pound practice bombs, and the remnants of a 100-pound practice bomb. Tables 5-2 and 5-3 present the location, description, quantity, and final disposition of MEC and MD items recovered for land and beach, and inland water areas, respectively. MD items were transferred to the secure MD storage area, and transported to the RM Packer Company for recycling. The disposal documentation for MEC investigation activities performed at the AOI during this RI is included in Appendix H.

Land and Beach

5.1.4.2 During intrusive investigation activities within land and beach areas, 83 MEC items and 279 items of MD were recovered. MEC items were recovered within 7 grids located adjacent to the former target location consisting of AN-MK23 3-pound bombs with spotting charges intact. One MEC item was identified with P0034 located adjacent east of the historical target area. MD items were recovered in 30 grids located and consisted of expended AN-MK23 3-pound bombs. No MEC or MD items were recovered within the ten intrusive investigation grids located in the residential area north of Shear Pen Pond. Table 5-2 presents the location, description, quantity, and final disposition of MEC and MD items recovered. All other anomalies investigated were identified as non-MD (174 items of wire, nails, anchors, fence posts, lengths of pipe) or cultural artifacts including remnants of shipwrecks in 5 grids. The UXB Site Manager's daily reports and photographs taken during the investigation at the AOI are included in Appendix E and I, respectively. The results of the intrusive investigations are presented in Figure 5-3.

Table 5-2. Summary of MEC and MD Recovered (Land and Beach)
Former Cape Poge Little Neck Bomb Target Area of Investigation

	Dig Descriptions						
Grid	MEC	MPPEH	MD	Non-MD	CA	Cleared	Comments
P0001	0	0	0	1	0	1-March	Harrier habitat
P0002	0	0	0	1	0	22-March	Relocated away from surf
P0003	0	0	0	0	0	22-March	Relocated away from surf/2 No finds
P0004	0	0	0	6	0	15-March	
P0005	0	0	0	0	0	15-March	Depth of 2 items exceeded 3-feet.
P0006	0	0	0	11	0	17-March	Changed to 25-feet x100-feet. Terrain would not allow EM61 to cover 50-feet x50-feet.
P0007	0	0	0	9	0	28-March	Changed to 25-feet x 100-feet. Terrain would not allow EM61 to cover 50-feet x 50-feet.
P0008	0	0	0	5	0	17-March	
P0009	0	0	0	13	0	17-March	Changed to 25-feet x100-feet. Terrain would not allow EM61 to cover 50-feet x50-feet.
P0010					1	---	Could not clear due to shipwreck debris
P0011	0	0	0	1	4	---	Could not clear due to shipwreck debris
P0012	0	0	0	2	0	14-March	
P0013	0	0	1	1	0	14-March	Expended MK-23
P0014	0	0	0	15	0	14-March	Several fence posts
P0015	0	0	0	19	0	14-March	Several fence posts
P0016	0	0	0	3	0	14-March	
P0017	0	0	0	14	0	28-March	
P0018	0	0	1	1	0	23-March	
P0019	0	0	1	2	0	21-March	
P0020	2	0	0	3	0	30-March	
P0021	6	0	3	8	0	30-March	Naeva reacquired
P0022	0	0	1	1	0	21-March	
P0023	9	0	42	3	0	11-April	
P0024	1	0	44	3	0	31-March	
P0025	0	0	4	9	0	28-March	Found MK-23 on surface during brush clearance.

Table 5-2. Summary of MEC and MD Recovered (Land and Beach) (continued)
Former Cape Poge Little Neck Bomb Target Area of Investigation

Grid	Dig Descriptions					Cleared	Comments
	MEC	MPPEH	MD	Non-MD	CA		
P0026	9	0	37	9	0	30-March	
P0027	32	0	92	1	0	28-March	Naeva reacquired
P0028	6	0	37	4	0	7-April	
P0029	17	0	16	1	0	11-April	
P0030	0	0	0	0	0	4-April	Reserve Grid/0 anomalies
P0031	0	0	0	3	0	4-April	Reserve Grid
P0032	0	0	0	4	0	4-April	Reserve Grid
P0033	0	0	0	1	0	4-April	Reserve Grid
P0034	1	0	0	0	0	6-April	Reserve Grid
P0035	0	0	0	0	0	4-April	Reserve Grid/0 anomalies
P0036	0	0	0	0	0	4-April	Reserve Grid/1 No find
P0037	0	0	0	0	0	---	Reserve Grid/UXB completed DGM, 25 anomalies not dug.
P0038	0	0	0	2	0	4-April	Reserve Grid
Totals	**83**	**0**	**279**	**156**	**5**		

Notes:
MK – mark
UXB – UXB International, Inc.
DGM – digital geophysical mapping
MEC – munitions and explosives of concern
MPPEH - material potentially presenting an explosive hazard
MD – munitions debris
CA – cultural artifact

Inland Water

5.1.4.3 Based on geophysical surveys, 11 inland water grids (P39-P49A) were selected for intrusive investigation. The grids were located within Shear Pen Pond (1 grid), Drunkard's Cove (3 grids), and Cape Poge Bay (7 grids), and each measured approximately 60 m by 13 m. During the investigation, 5 MEC items, 44 MD items, and 22 non-MD items were identified and recovered by the UXO dive team. The MEC items were recovered at two locations; one MEC item was located west of the historic target in Cape Poge Bay (P0043) and three MEC items were recovered within Shear Pen Pond (P0049). Table 5-3 presents the location, description, quantity, and final disposition of MEC and MD items recovered. The greatest number of MD items were recovered in Grids P0043, P0044, and P0045, which are located closest to the historic target location. No MEC or MD items were recovered within Grids P0047 and P0039 (Figure 5-3).

Ocean

5.1.4.4 Mag and Dig operations were conducted along 26 ocean transects in the surfzone along the eastern and northern shore of Cape Poge. No MEC, MPPEH, or MD or non-MD items were identified on any of the transects.

US Army Corps of Engineers

FIGURE 5-3

Geophysical Survey Transect and Intrusive Grid Results
Former Cape Poge Little Neck Bomb Target Area of Investigation
Martha's Vineyard, MA

0 150 300 600 900 Meters
0 500 1,000 2,000 3,000 Feet

UXB amec

NOTES:
2011 Aerial Data Source: Bing Maps, Microsoft Corp.

05/04/2012	Rev: 06/28/2012	CPoge_All_Activities_Results_Remdial_Inv_Rpt.mxd
Drawn: JBO	Chk: DMS	PROJ: 562910000

Table 5-3. Summary of MEC and MD Recovered (Inland Water)
Former Cape Poge Little Neck Bomb Target Area of Investigation

Grid	DGM Complete	Dig List Complete	Dug	Dig Descriptions					Cleared	Comments
				MEC	MPPEH	MD	Non-MD	CA		
P0039	20-April	21-April	15-June	N/A	N/A	2	N/A	N/A	16-June	2-Expended MK-23's
P0040	20-April	21-April	27-May	N/A	N/A	2	N/A	N/A	27-May	2-Expended MK-23's
P0041	21-April	22-April	6-June	N/A	N/A	4	3	N/A	6-June	4-Expended MK-23's
P0042	27-April	28-April	7-June	N/A	N/A	4	N/A	N/A	7-June	4-Expended MK-23's
P0043	21-April	22-April	7-June	1	N/A	10	N/A	N/A	8-June	10-Expended MK-23's/1-Mk-23 with intact spotting charge
P0044	29-April	3-May	9-June	N/A	N/A	5	N/A	N/A	13-June	5-Expended MK-23's
P0045	29-April	3-May	13-June	N/A	N/A	12	N/A	N/A	15-June	11-Expended MK-23's/1-Expended 100 lb. practice bomb
P0046	27-April	28-April	25-May	N/A	N/A	1	1	N/A	25-May	1-Expended MK-23
P0047	22-April	25-April	26-May	N/A	N/A	N/A	2	N/A	26-May	
P0048	22-April	25-April	31-May	N/A	N/A	2	N/A	N/A	31-May	2-Expended MK-23's
P0049	22-April	25-April	31-May	4	N/A	4	1	N/A	2-June	4-Expended MK-23's/4-Mk-23 with intact spotting charge
Totals				**5**	**0**	**46**	**7**	**0**		

Notes:
DGM – digital geophysical mapping
MEC – munitions and explosives of concern
MPPEH - material potentially presenting an explosive hazard
MD – munitions debris
CA – cultural artifact
N/A – not applicable
MK - mark

5.2 MC Investigation Results

5.2.1 Soil

5.2.1.1 Based on the results of the intrusive investigation, three incremental soil (0 to 2 in. bgs), 24 discrete surface soil (2 to 12 in. bgs), and 23 discrete subsurface soil (12 to 18 in. bgs) sample locations were identified at the AOI. Since environmental sampling had not been previously conducted, initial samples were collected to determine the presence or absence of MCs.

5.2.1.2 Analytical results from surface and subsurface soil sampling are presented in Tables 5-4 and 5-6, respectively. A statistical summary of surface and subsurface soil data collected at the site are presented in Tables 5-5 and 5-7, respectively. MC sampling results are shown on Figure 5-4. Analytical Laboratory Reports are included in Appendix D. A summary of the results is presented below.

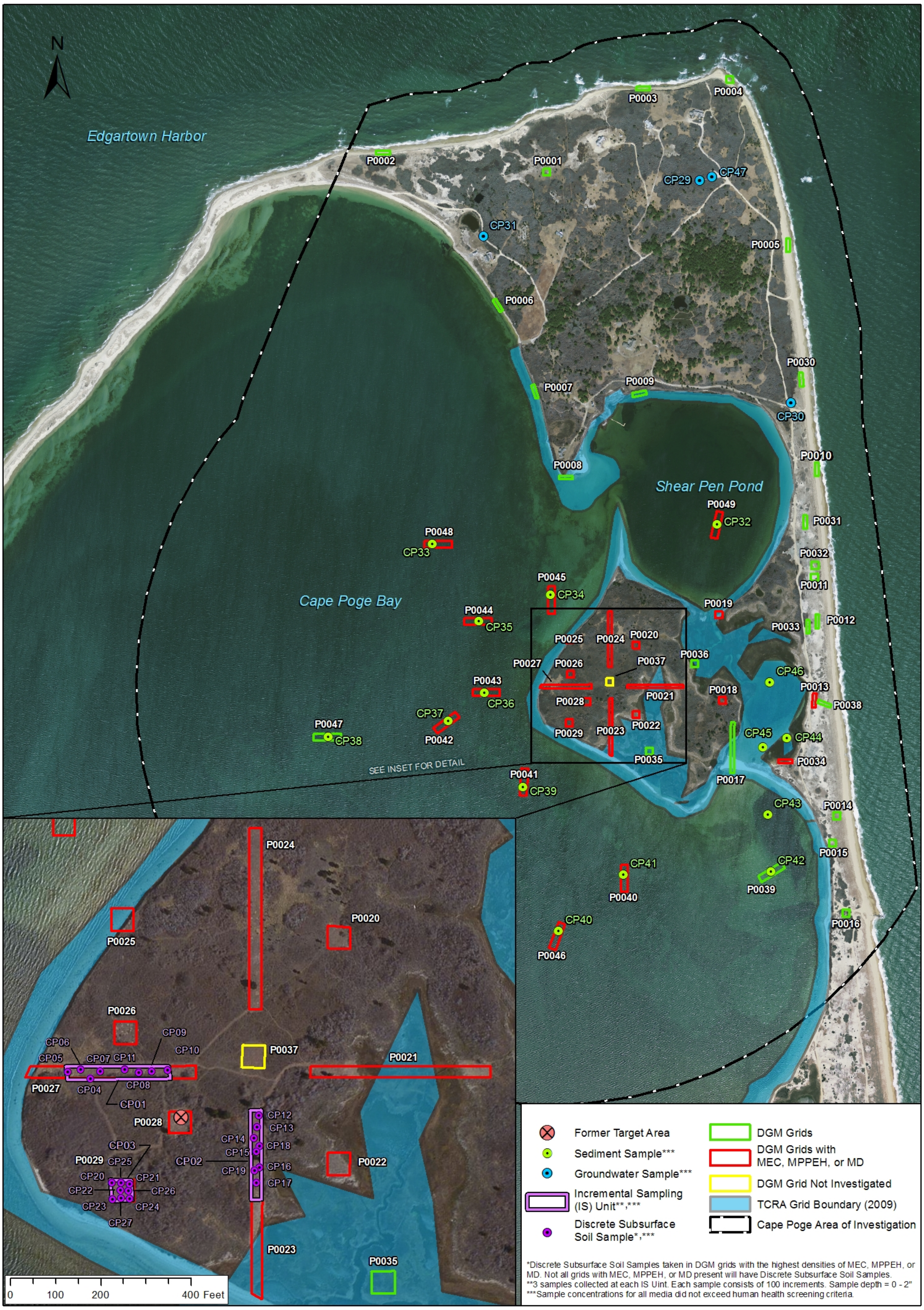
Metals

5.2.1.3 Metals (antimony, copper, lead, nickel, and zinc) were analyzed in surface soil samples, which were collected at 3 incremental sample locations and 24 discrete sample locations. Antimony (7 locations), copper (26 locations), lead (all locations), nickel (all locations), and zinc (all locations) were detected in surface soil samples collected at the site. Antimony was detected at concentrations above the ecological screening criterion at 3 incremental sample locations and at 4 discrete surface soil sample locations (CP08, CP10, CP11, and CP14). Lead was detected above the ecological screening criterion at all surface soil sample locations. Zinc was detected above the ecological screening criterion at 3 incremental sample locations and at 7 discrete surface soil sample locations (CP05, CP07, CP08, CP09, CP10, CP11, and CP14). None of the metals were detected in surface soil at concentrations exceeding the human health soil screening criterion.

5.2.1.4 Metals were also analyzed in subsurface soil samples, which were collected at 23 discrete locations. Antimony was detected at three subsurface sample locations, while copper, lead, nickel, and zinc were detected at each sample location. Lead and nickel were detected at concentrations exceeding the ecological screening criterion at each sample location. Zinc was detected above the ecological screening criterion at 13 subsurface soil sample locations (CP07, CP08, CP09, CP10, CP11, CP12, CP14, CP16, CP18, CP21, CP23, CP26, and CP27), located within the incremental sample units. No metals were detected in subsurface soil at concentrations exceeding the human health soil screening criterion.

Explosives

5.2.1.5 Explosives were analyzed in surface and subsurface soil samples. No explosives compounds were detected in surface or subsurface soil samples.



*Discrete Subsurface Soil Samples taken in DGM grids with the highest densities of MEC, MPPEH, or MD. Not all grids with MEC, MPPEH, or MD present will have Discrete Subsurface Soil Samples.
**3 samples collected at each IS Uint. Each sample consists of 100 increments. Sample depth = 0 - 2"
***Sample concentrations for all media did not exceed human health screening criteria.

US Army Corps
of Engineers

FIGURE 5-4
MC Sampling Locations and Results
Former Cape Poge Little Neck Bomb Target Area of Investigation
Martha's Vineyard, MA

0 150 300 600 900 Meters
0 500 1,000 2,000 3,000 Feet

UXB amec

NOTES:
2011 Aerial Data Source:
Bing Maps, Microsoft Corp.

04/12/2012
Rev:
CPoge_MC_Sampling_Results_Remedial_Inv_Rpt1.mxd
Drawn: JBO
Chk: DMS
PROJ: 562910000

Table 5-4. Surface Soil Sample Results Summary
Former Cape Poge Little Neck Bomb Target Area of Investigation

Location ID	Sample ID	Sample Date	Sample Type	Sample Depth Interval (inches)	Metals by 6020A				
					Antimony	Copper	Lead	Nickel	Zinc
Human Health Screening Criterion$^{(1)}$					20	3100	300	20	2500
Ecological Screening Criterion$^{(2)}$					0.142	5.4	0.0537	13.6	6.62
Results are presented in milligrams per kilogram (mg/kg)									
CP01	CP01 IS01	10/16/2011	Regular	0-2	**0.057 J**	**2.7**	**22**	**1.5**	**11**
CP01	CP01 IS02	10/16/2011	FT	0-2	**0.083 J**	**2.3**	**25**	**1.6**	**13**
CP01	CP01 IS03	10/16/2011	FT	0-2	**0.028 J**	**2.4**	**14**	**1.5**	**10**
CP02	CP02 IS004	10/17/2011	Regular	0-2	**0.043 J**	**2.8**	**14**	**1.5**	**8.8**
CP02	CP02 IS005	10/17/2011	FT	0-2	**0.049 J**	**3.2**	**15**	**1.5**	**10**
CP02	CP02 IS006	10/17/2011	FT	0-2	**0.053 J**	**3.6**	**16**	**2**	**12**
CP03	CP03 IS007	10/18/2011	Regular	0-2	**0.016 J**	**2 J**	**9.1**	**1.3**	**9.2**
CP03	CP03 IS008	10/18/2011	FT	0-2	**0.014 J**	**1.8 J**	**8**	**1.3**	**8.8**
CP03	CP03 IS009	10/18/2011	FT	0-2	**0.017 J**	**2.1 J**	**9**	**1.6**	**9.7**
CP04	CP04 SB001	10/16/2011	Regular	2-12	0.2 U	**1.1 J**	**6.1**	**0.83**	**5.1**
CP05	CP05 SB003	10/16/2011	Regular	2-12	0.21 U	**1.1 J**	**5.2**	**0.84**	**7**
CP06	CP06 SB005	10/16/2011	Regular	2-12	0.21 U	**1.2 J**	**4.5**	**1**	**5.8**
CP07	CP07 SB007	10/16/2011	Regular	2-12	0.21 U	**1.1 J**	**6.5**	**1.4**	**7.8**
CP08	CP08 SB009	10/16/2011	Regular	2-12	**0.018 J**	**1.2 J**	**7.8**	**1.7**	**8.1**
CP09	CP09 SB012	10/16/2011	Regular	2-12	0.2 U	**0.98 J**	**14**	**1.3**	**7.3**
CP10	CP10 SB014	10/16/2011	Regular	2-12	**0.02 J**	**1.4 J**	**7.5**	**1.8**	**9.7**
CP11	CP11 SB16A	10/16/2011	Regular	2-12	**0.39**	**2.1 J**	**82**	**2.5**	**19**
CP12	CP12 SB017	10/16/2011	Regular	2-12	0.19 U	**1.2 J**	**21**	**1.6**	**6**
CP13	CP13 SB019	10/17/2011	Regular	2-12	0.23 U	**1.2 J**	**6.4**	**1.1**	**4.3**
CP13	CP13 SB021	10/17/2011	FD	2-12	0.23 U	**0.9 J**	**6.4**	**1**	**3.9**
CP14	CP14 SB023	10/17/2011	Regular	2-12	**0.018 J**	**1.3 J**	**9**	**1.9**	**7.9**

Table 5-4. Surface Soil Sample Results Summary (continued)
Former Cape Poge Little Neck Bomb Target Area of Investigation

Location ID	Sample ID	Sample Date	Sample Type	Sample Depth Interval (inches)	Metals by 6020A				
					Antimony	Copper	Lead	Nickel	Zinc
Human Health Screening Criterion[1]					20	3100	300	20	2500
Ecological Screening Criterion[2]					0.142	5.4	0.0537	13.6	6.62
Results are presented in milligrams per kilogram (mg/kg)									
CP15	CP15 SB025	10/17/2011	Regular	2-12	0.21 U	**1.1 J**	**7**	**1.1**	**4.6**
CP16	CP16 SB027	10/17/2011	Regular	2-12	0.23 U	**1.1 J**	**13**	**1.5**	**4**
CP17	CP17 SB029	10/17/2011	Regular	2-12	0.2 U	0.68 U	**9.4**	**1.4**	**4.2**
CP18	CP18 SB031	10/17/2011	Regular	2-12	0.22 U	**1.2 J**	**11**	**1.2**	**4.2**
CP19	CP19 SB034	10/17/2011	Regular	2-12	0.24 U	**1.1 J**	**17**	**1.5**	**4.8**
CP20	CP20 SB037	10/18/2011	Regular	2-12	0.22 U	**1 J**	**3.7**	**1.7**	**5.7**
CP21	CP21 SB038	10/18/2011	Regular	2-12	0.23 U	**1.1 J**	**8.7**	**1.5**	**6**
CP22	CP22 SB040	10/18/2011	Regular	2-12	0.22 U	**0.93 J**	**5.4**	**1.2**	**5.4**
CP23	CP23 SB042	10/18/2011	Regular	2-12	0.23 U	**1.2 J**	**6.7**	**1.8**	**7.2**
CP23	CP23 SB044	10/18/2011	FD	2-12	0.21 U	**1.1 J**	**6.2**	**1.9**	**6.7**
CP24	CP24 SB046	10/18/2011	Regular	2-12	0.2 U	**0.79 J**	**4.5**	**0.96**	**4.9**
CP25	CP25 SB048	10/18/2011	Regular	2-12	0.19 U	**0.68 J**	**4.6**	**0.64**	**4.2**
CP26	CP26 SB050	10/18/2011	Regular	2-12	0.22 U	**1.2 J**	**6.1**	**2**	**7.3**
CP27	CP27 SB052	10/18/2011	Regular	2-12	0.2 U	**0.86 J**	**4.5**	**1.6**	**5.6**

Notes:

[1] Criteria for human health were identified as the lower of 1) U.S. Environmental Protection Agency Regional Screening Level (residential selected as the most stringent) 2) Massachusetts Department of Environmental Protection Method 1 Soil Standard (SI value selected for the greatest stringency)

[2] Criteria for ecological were identified using the lower of 1) U.S. Environmental Protection Agency Ecological Soil Screening Level (lowest of avian, mammalian, plant or invertebrate) 2) Region 5 Ecological Screening Level 3) Region 4 Ecological Screening Value.

🟦 Detected concentration is greater than ecological screening criterion.

Acronyms

FD - field duplicate	**J** - quantitation estimated
FT - field triplicate	**U** - not detected

Table 5-4. Surface Soil Sample Results Summary (continued)
Former Cape Poge Little Neck Bomb Target Area of Investigation

						Explosives by 8321B																															
Location ID	Sample ID	Sample Date	Sample Type	Sample Depth Interval (inches)		1,3,5-Trinitrobenzene		1,3-Dinitrobenzene		2,4,6-Trinitrotoluene		2,4-Dinitrotoluene		2,6-Dinitrotoluene		2-Amino-4,6-dinitrotoluene		2-Nitrotoluene		3-Nitrotoluene		4-Amino-2,6-dinitrotoluene		4-Nitrotoluene		HMX		Nitrobenzene		Nitroglycerin		PETN		RDX		Tetryl	
Human Health Screening Criterion(1)						2200		6.1		19		0.7		61		150		2.9		2.9		150		30		1		4.8		6.1		120		1		240	
Ecological Screening Criterion(2)						0.376		0.073		6.4		0.52		0.328		0.73		2		2.4		2.1		4.4		27		1.31		71		8600		7.5		0.99	
Results are presented in milligrams per kilogram (mg/kg)																																					
CP01	CP01 IS01	10/16/2011	IS	0	2	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U
CP01	CP01 IS02	10/16/2011	FT	0	2	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U
CP01	CP01 IS03	10/16/2011	FT	0	2	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U
CP02	CP02 IS004	10/17/2011	IS	0	2	0.091	U	0.091	U	0.091	U	0.091	U	0.091	U	0.091	U	0.091	U	0.091	U	0.091	U	0.091	U	0.091	U	0.091	U	0.091	U	0.091	U	0.091	U	0.091	U
CP02	CP02 IS005	10/17/2011	FT	0	2	0.093	U	0.093	U	0.093	U	0.093	U	0.093	U	0.093	U	0.093	U	0.093	U	0.093	U	0.093	U	0.093	U	0.093	U	0.093	U	0.093	U	0.093	U	0.093	U
CP02	CP02 IS006	10/17/2011	FT	0	2	0.097	U	0.097	U	0.097	UJ	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U
CP03	CP03 IS007	10/18/2011	IS	0	2	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U
CP03	CP03 IS008	10/18/2011	FT	0	2	0.093	U	0.093	U	0.093	U	0.093	U	0.093	U	0.093	U	0.093	U	0.093	U	0.093	U	0.093	U	0.093	U	0.093	U	0.093	U	0.093	U	0.093	U	0.093	U
CP03	CP03 IS009	10/18/2011	FT	0	2	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U
CP04	CP04 SB001	10/16/2011	Regular	2	12	0.094	U	0.094	U	0.094	U	0.094	U	0.094	U	0.094	U	0.094	U	0.094	U	0.094	U	0.094	U	0.094	U	0.094	U	0.094	U	0.094	U	0.094	U	0.094	U
CP05	CP05 SB003	10/16/2011	Regular	2	12	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U
CP06	CP06 SB005	10/16/2011	Regular	2	12	0.092	U	0.092	U	0.092	U	0.092	U	0.092	U	0.092	U	0.092	U	0.092	U	0.092	U	0.092	U	0.092	U	0.092	U	0.092	U	0.092	U	0.092	U	0.092	U
CP07	CP07 SB007	10/16/2011	Regular	2	12	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U
CP08	CP08 SB009	10/16/2011	Regular	2	12	0.095	U	0.095	U	0.095	U	0.095	U	0.095	U	0.095	U	0.095	U	0.095	U	0.095	U	0.095	U	0.095	U	0.095	U	0.095	U	0.095	U	0.095	U	0.095	U
CP09	CP09 SB012	10/16/2011	Regular	2	12	0.098	U	0.098	U	0.098	U	0.098	U	0.098	U	0.098	U	0.098	U	0.098	U	0.098	U	0.098	U	0.098	U	0.098	U	0.098	U	0.098	U	0.098	U	0.098	U
CP10	CP10 SB014	10/16/2011	Regular	2	12	0.095	U	0.095	U	0.095	U	0.095	U	0.095	U	0.095	U	0.095	U	0.095	U	0.095	U	0.095	U	0.095	U	0.095	U	0.095	U	0.095	U	0.095	U	0.095	U
CP11	CP11 SB16A	10/16/2011	Regular	2	12	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U
CP12	CP12 SB017	10/16/2011	Regular	2	12	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U
CP13	CP13 SB019	10/17/2011	Regular	2	12	0.093	U	0.093	U	0.093	U	0.093	U	0.093	U	0.093	U	0.093	U	0.093	U	0.093	U	0.093	U	0.093	U	0.093	U	0.093	U	0.093	U	0.093	U	0.093	U
CP13	CP13 SB021	10/17/2011	FD	2	12	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U
CP14	CP14 SB023	10/17/2011	Regular	2	12	0.094	U	0.094	U	0.094	U	0.094	U	0.094	U	0.094	U	0.094	U	0.094	U	0.094	U	0.094	U	0.094	U	0.094	U	0.094	U	0.094	U	0.094	U	0.094	U
CP15	CP15 SB025	10/17/2011	Regular	2	12	0.094	U	0.094	U	0.094	U	0.094	U	0.094	U	0.094	U	0.094	U	0.094	U	0.094	U	0.094	U	0.094	U	0.094	U	0.094	U	0.094	U	0.094	U	0.094	U
CP16	CP16 SB027	10/17/2011	Regular	2	12	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U
CP17	CP17 SB029	10/17/2011	Regular	2	12	0.095	U	0.095	U	0.095	U	0.095	U	0.095	U	0.095	U	0.095	U	0.095	U	0.095	U	0.095	U	0.095	U	0.095	U	0.095	U	0.095	U	0.095	U	0.095	U
CP18	CP18 SB031	10/17/2011	Regular	2	12	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U
CP19	CP19 SB034	10/17/2011	Regular	2	12	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U
CP20	CP20 SB037	10/18/2011	Regular	2	12	0.098	U	0.098	U	0.098	U	0.098	U	0.098	U	0.098	U	0.098	U	0.098	U	0.098	U	0.098	U	0.098	U	0.098	U	0.098	U	0.098	U	0.098	U	0.098	U
CP21	CP21 SB038	10/18/2011	Regular	2	12	0.091	U	0.091	U	0.091	U	0.091	U	0.091	U	0.091	U	0.091	U	0.091	U	0.091	U	0.091	U	0.091	U	0.091	U	0.091	U	0.091	U	0.091	U	0.091	U
CP22	CP22 SB040	10/18/2011	Regular	2	12	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U
CP23	CP23 SB044	10/18/2011	FD	2	12	0.092	U	0.092	U	0.092	U	0.092	U	0.092	U	0.092	U	0.092	U	0.092	U	0.092	U	0.092	U	0.092	U	0.092	U	0.092	U	0.092	U	0.092	U	0.092	U
CP24	CP24 SB046	10/18/2011	Regular	2	12	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U
CP25	CP25 SB048	10/18/2011	Regular	2	12	0.094	U	0.094	U	0.094	U	0.094	U	0.094	U	0.094	U	0.094	U	0.094	U	0.094	U	0.094	U	0.094	U	0.094	U	0.094	U	0.094	U	0.094	U	0.094	U
CP26	CP26 SB050	10/18/2011	Regular	2	12	0.092	U	0.092	U	0.092	U	0.092	U	0.092	U	0.092	U	0.092	U	0.092	U	0.092	U	0.092	U	0.092	U	0.092	U	0.092	U	0.092	U	0.092	U	0.092	U
CP27	CP27 SB052	10/18/2011	Regular	2	12	0.098	U	0.098	U	0.098	U	0.098	U	0.098	U	0.098	U	0.098	U	0.098	U	0.098	U	0.098	U	0.098	U	0.098	U	0.098	U	0.098	U	0.098	U	0.098	U

Table 5-5. Surface Soil Data Statistical Summary
Former Cape Poge Little Neck Bomb Target Area of Investigation

Constituent	Human Health Screening Criterion(1) (mg/kg)	Ecological Screening Criterion(2) (mg/kg)	Analyzed	Detected	Percent of Detection	Exceeded HHSC	Exceeded ECOSC	Percent Exceeded ECOSC	Minimum Detection (mg/kg)	Maximum Detection (mg/kg)	Maximum Detection Location
Incremental Samples 0-2 inches											
Antimony	20	0.142	9	9	100	0	0	0	0.014	0.083	CP01 IS02
Copper	3100	5.4	9	9	100	0	0	0	1.8	3.6	CP02 IS006
Lead	300	0.0537	9	9	100	0	9	100	8	25	CP01 IS02
Nickel	20	13.6	9	9	100	0	0	0	1.3	2	CP02 IS006
Zinc	2500	6.62	9	9	100	0	9	100	8.8	13	CP01 IS02
Discrete Samples 2-12 inches											
Antimony	20	0.142	26	4	15	0	1	4	0.02	0.39	CP11 SB16A
Copper	3100	5.4	26	25	96	0	0	0	0.68	2.1	CP11 SB16A
Lead	300	0.0537	26	26	100	0	26	100	3.7	82	CP11 SB16A
Nickel	20	13.6	26	26	100	0	0	0	0.64	2.5	CP11 SB16A
Zinc	2500	6.62	26	26	100	0	10	38	3.9	19	CP11 SB16A
Incremental and Discrete Samples											
1,3,5-Trinitrobenzene	2200	0.376	35	0	0	0	0	0	n/a	n/a	n/a
1,3-Dinitrobenzene	6.1	0.073	35	0	0	0	0	0	n/a	n/a	n/a
2,4,6-Trinitrotoluene	19	6.4	35	0	0	0	0	0	n/a	n/a	n/a
2,4-Dinitrotoluene	0.7	1.28	35	0	0	0	0	0	n/a	n/a	n/a
2,6-Dinitrotoluene	61	0.0328	35	0	0	0	0	0	n/a	n/a	n/a

Table 5-5. Surface Soil Data Statistical Summary (continued)
Former Cape Poge Little Neck Bomb Target Area of Investigation

Constituent	Human Health Screening Criterion(1) (mg/kg)	Ecological Screening Criterion(2) (mg/kg)	Analyzed	Detected	Percent of Detection	Exceeded HHSC	Exceeded ECOSC	Percent Exceeded ECOSC	Minimum Detection (mg/kg)	Maximum Detection (mg/kg)	Maximum Detection Location
2-Amino-4,6-dinitrotoluene	150	10	35	0	0	0	0	0	n/a	n/a	n/a
2-Nitrotoluene	2.9	9.9	35	0	0	0	0	0	n/a	n/a	n/a
3-Nitrotoluene	2.9	12	35	0	0	0	0	0	n/a	n/a	n/a
4-Amino-2,6-dinitrotoluene	150	3.6	35	0	0	0	0	0	n/a	n/a	n/a
4-Nitrotoluene	30	22	35	0	0	0	0	0	n/a	n/a	n/a
HMX	1	27	35	0	0	0	0	0	n/a	n/a	n/a
Nitrobenzene	4.8	1.31	35	0	0	0	0	0	n/a	n/a	n/a
Nitroglycerin	6.1	71	35	0	0	0	0	0	n/a	n/a	n/a
PETN	120	100	35	0	0	0	0	0	n/a	n/a	n/a
RDX	1	7.5	35	0	0	0	0	0	n/a	n/a	n/a
Tetryl	240	0.99	35	0	0	0	0	0	n/a	n/a	n/a

Notes:

(1) Criteria for human health were identified as the lower of 1) USEPA RSL (residential selected as the most stringent) 2) MADEP Method 1 Soil Standard (SI value selected for the greatest stringency).

(2) Criteria for ecological were identified using the lower of 1) USEPA EcoSSL (lowest of avian, mammalian, plant or invertebrate) 2) Region 5 ESL 3) Region 4 ESV.

mg/kg - milligrams per kilogram
n/a – not applicable
HMX - 1,3,5,7-tetranitro-1,3,5,7-tetrazocine
RDX - 1,3,5-trinitro-1,3,5-triazine
PETN - pentaerythrite tetranitrate

Table 5-6. Subsurface Soil Sample Results Summary
Former Cape Poge Little Neck Bomb Target Area of Investigation

Location ID	Sample ID	Sample Date	Sample Type	Sample Depth Interval (inches)	Metals by 6020A							
					Antimony		Copper		Lead	Nickel		Zinc
Human Health Screening Criterion(1)					20		3100		300	20		2500
Ecological Screening Criterion(2)					0.142		5.4		0.0537	13.6		6.62
Results are presented in milligrams per kilogram (mg/kg)												
CP05	CP05 SB004	10/16/2011	Regular	12-18	0.21	U	**0.85**	**J**	**2.4**	**0.94**		**5.7**
CP06	CP06 SB006	10/16/2011	Regular	12-18	0.21	U	**0.75**	**J**	**2.5**	**1.3**		**5.9**
CP07	CP07 SB008	10/16/2011	Regular	12-18	0.21	U	**0.78**	**J**	**2.9**	**1.6**		**7.3**
CP08	CP08 SB010	10/16/2011	Regular	12-18	**0.015**	**J**	**1.4**	**J**	**7**	**2.2**		**11**
CP08	CP08 SB011	10/16/2011	FD	12-18	0.22	U	**1.4**	**J**	**6.8**	**2.1**		**11**
CP09	CP09 SB013	10/16/2011	Regular	12-18	0.19	U	**0.85**	**J**	**4.7**	**1.8**		**7.5**
CP10	CP10 SB015	10/16/2011	Regular	12-18	**0.016**	**J**	**1.3**	**J**	**4.9**	**2.2**		**10**
CP11	CP11 SB16B	10/16/2011	Regular	12-18	**0.072**	**J**	**1.3**	**J**	**17**	**2.8**		**11**
CP12	CP12 SB018	10/16/2011	Regular	12-18	0.19	U	**1.7**	**J**	**6.6**	**4.4**		**9.9**
CP13	CP13 SB020	10/17/2011	Regular	12-18	0.21	UJ	**1.1**	**J**	**4.5**	**2.4**		**5.5**
CP14	CP14 SB024	10/17/2011	Regular	12-18	0.21	U	**1.1**	**J**	**4.8**	**3.5**		**7.6**
CP15	CP15 SB026	10/17/2011	Regular	12-18	0.21	U	**0.95**	**J**	**6.9**	**2.2**		**6.3**
CP16	CP16 SB028	10/17/2011	Regular	12-18	0.23	U	**1.6**	**J**	**8.3**	**4.4**		**8.5**
CP17	CP17 SB030	10/17/2011	Regular	12-18	0.2	U	**1**	**J**	**4.3**	**2.7**		**5.8**
CP18	CP18 SB032	10/17/2011	Regular	12-18	0.2	U	**1.1**	**J**	**7.8**	**2.2**	**J**	**5.7**
CP18	CP18 SB033	10/17/2011	FD	12-18	0.21	U	**1.1**	**J**	**7.5**	**3.2**	**J**	**7.9**
CP19	CP19 SB035	10/17/2011	Regular	12-18	0.21	U	**1.5**	**J**	**11**	**2.8**		**6.4**
CP20	CP20 SB036	10/18/2011	Regular	12-18	0.2	U	**1.1**	**J**	**6.1**	**1.1**		**5.8**
CP21	CP21 SB039	10/18/2011	Regular	12-18	0.22	U	**1.3**	**J**	**7**	**2.7**		**8.1**
CP22	CP22 SB041	10/18/2011	Regular	12-18	0.2	U	**0.82**	**J**	**3**	**1.9**		**5.5**
CP23	CP23 SB043	10/18/2011	Regular	12-18	0.2	UJ	**1.3**	**J**	**4**	**3.7**		**7.8**
CP24	CP24 SB047	10/18/2011	Regular	12-18	0.21	U	**1.2**	**J**	**4.1**	**2.5**		**6.6**

Table 5-6. Subsurface Soil Sample Results Summary (continued)
Former Cape Poge Little Neck Bomb Target Area of Investigation

Location ID	Sample ID	Sample Date	Sample Type	Sample Depth Interval (inches)	Metals by 6020A						
					Antimony		Copper		Lead	Nickel	Zinc
Human Health Screening Criterion(1)					20		3100		300	20	2500
Ecological Screening Criterion(2)					0.142		5.4		0.0537	13.6	6.62
Results are presented in milligrams per kilogram (mg/kg)											
CP25	CP25 SB049	10/18/2011	Regular	12-18	0.2	U	**0.69**	**J**	**3.2**	**1.3**	**5.7**
CP26	CP26 SB051	10/18/2011	Regular	12-18	0.2	U	**1.6**	**J**	**4.2**	**4.3**	**9.8**
CP27	CP27 SB053	10/18/2011	Regular	12-18	0.21	U	**1.2**	**J**	**4**	**3.3**	**6.9**

Notes:

(1) Criteria for human health were identified as the lower of 1) U.S. Environmental Protection Agency Regional Screening Level (residential selected as the most stringent) 2) Massachusetts Department of Environmental Protection Method 1 Soil Standard (SI value selected for the greatest stringency).

(2) Criteria for ecological were identified using the lower of 1) U.S. Environmental Protection Agency Ecological Soil Screening Level (lowest of avian, mammalian, plant or invertebrate) 2) Region 5 Ecological Screening Level 3) Region 4 Ecological Screening Level.

🟦 Detected concentration is greater than ecological screening criterion.

Acronyms

FD - field duplicate

J - quantitation estimated

U - not detected

Table 5-6. Subsurface Soil Sample Results Summary (continued)
Former Cape Poge Little Neck Bomb Target Area of Investigation

						Explosives by 8321B															
Location ID	Sample ID	Sample Date	Sample Type	Sample Depth Interval (inches)		1,3,5-Trinitrobenzene	1,3-Dinitrobenzene	2,4,6-Trinitrotoluene	2,4-Dinitrotoluene	2,6-Dinitrotoluene	2-Amino-4,6-dinitrotoluene	2-Nitrotoluene	3-Nitrotoluene	4-Amino-2,6-dinitrotoluene	4-Nitrotoluene	HMX	Nitrobenzene	Nitroglycerin	PETN	RDX	Tetryl
Human Health Screening Criterion(1)						2200	6.1	19	0.7	61	150	2.9	2.9	150	30	1	4.8	6.1	120	1	240
Ecological Screening Criterion(2)						0.376	0.073	6.4	0.52	0.328	0.73	2	2.4	2.1	4.4	27	1.31	71	8600	7.5	0.99
Results are presented in milligrams per kilogram (mg/kg)																					
CP04	CP04 SB002	10/16/2011	Regular	12	18	0.098 U	0.098 U	0.098 U	0.098 U	0.098 U	0.098 U	0.098 U	0.098 U	0.098 U	0.098 U	0.098 U	0.098 U	0.098 U	0.098 U	0.098 U	0.098 U
CP05	CP05 SB004	10/16/2011	Regular	12	18	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U
CP06	CP06 SB006	10/16/2011	Regular	12	18	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U
CP07	CP07 SB008	10/16/2011	Regular	12	18	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U
CP08	CP08 SB010	10/16/2011	Regular	12	18	0.096 U	0.096 U	0.096 U	0.096 U	0.096 U	0.096 U	0.096 U	0.096 U	0.096 U	0.096 U	0.096 U	0.096 U	0.096 U	0.096 U	0.096 U	0.096 U
CP08	CP08 SB011	10/16/2011	FD	12	18	0.096 U	0.096 U	0.096 U	0.096 U	0.096 U	0.096 U	0.096 U	0.096 U	0.096 U	0.096 U	0.096 U	0.096 U	0.096 U	0.096 U	0.096 U	0.096 U
CP09	CP09 SB013	10/16/2011	Regular	12	18	0.093 U	0.093 U	0.093 U	0.093 U	0.093 U	0.093 U	0.093 U	0.093 U	0.093 U	0.093 U	0.093 U	0.093 U	0.093 U	0.093 U	0.093 U	0.093 U
CP10	CP10 SB015	10/16/2011	Regular	12	18	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U
CP11	CP11 SB16B	10/16/2011	Regular	12	18	0.095 U	0.095 U	0.095 U	0.095 U	0.095 U	0.095 U	0.095 U	0.095 U	0.095 U	0.095 U	0.095 U	0.095 U	0.095 U	0.095 U	0.095 U	0.095 U
CP12	CP12 SB018	10/16/2011	Regular	12	18	0.098 U	0.098 U	0.098 U	0.098 U	0.098 U	0.098 U	0.098 U	0.098 U	0.098 U	0.098 U	0.098 U	0.098 U	0.098 U	0.098 U	0.098 U	0.098 U
CP13	CP13 SB020	10/17/2011	Regular	12	18	0.091 U	0.091 U	0.091 U	0.091 U	0.091 U	0.091 U	0.091 U	0.091 U	0.091 U	0.091 U	0.091 U	0.091 U	0.091 U	0.091 U	0.091 U	0.091 U
CP14	CP14 SB024	10/17/2011	Regular	12	18	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U
CP15	CP15 SB026	10/17/2011	Regular	12	18	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U
CP16	CP16 SB028	10/17/2011	Regular	12	18	0.093 U	0.093 U	0.093 U	0.093 U	0.093 U	0.093 U	0.093 U	0.093 U	0.093 U	0.093 U	0.093 U	0.093 U	0.093 U	0.093 U	0.093 U	0.093 U
CP17	CP17 SB030	10/17/2011	Regular	12	18	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U
CP18	CP18 SB032	10/17/2011	Regular	12	18	0.098 U	0.098 U	0.098 U	0.098 U	0.098 U	0.098 U	0.098 U	0.098 U	0.098 U	0.098 U	0.098 U	0.098 U	0.098 U	0.098 U	0.098 U	0.098 U
CP18	CP18 SB033	10/17/2011	FD	12	18	0.091 U	0.091 U	0.091 U	0.091 U	0.091 U	0.091 U	0.091 U	0.091 U	0.091 U	0.091 U	0.091 U	0.091 U	0.091 U	0.091 U	0.091 U	0.091 U
CP19	CP19 SB035	10/17/2011	Regular	12	18	0.097 U	0.097 U	0.097 U	0.097 U	0.097 U	0.097 U	0.097 U	0.097 U	0.097 U	0.097 U	0.097 U	0.097 U	0.097 U	0.097 U	0.097 U	0.097 U
CP20	CP20 SB036	10/18/2011	Regular	12	18	0.098 U	0.098 U	0.098 U	0.098 U	0.098 U	0.098 U	0.098 U	0.098 U	0.098 U	0.098 U	0.098 U	0.098 U	0.098 U	0.098 U	0.098 U	0.098 U
CP21	CP21 SB039	10/18/2011	Regular	12	18	0.095 U	0.095 U	0.095 U	0.095 U	0.095 U	0.095 U	0.095 U	0.095 U	0.095 U	0.095 U	0.095 U	0.095 U	0.095 U	0.095 U	0.095 U	0.095 U
CP22	CP22 SB041	10/18/2011	Regular	12	18	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U
CP23	CP23 SB043	10/18/2011	Regular	12	18	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U	0.099 U
CP24	CP24 SB047	10/18/2011	Regular	12	18	0.095 U	0.095 U	0.095 U	0.095 U	0.095 U	0.095 U	0.095 U	0.095 U	0.095 U	0.095 U	0.095 U	0.095 U	0.095 U	0.095 U	0.095 U	0.095 U
CP25	CP25 SB049	10/18/2011	Regular	12	18	0.096 U	0.096 U	0.096 U	0.096 U	0.096 U	0.096 U	0.096 U	0.096 U	0.096 U	0.096 U	0.096 U	0.096 U	0.096 U	0.096 U	0.096 U	0.096 U
CP26	CP26 SB051	10/18/2011	Regular	12	18	0.097 U	0.097 U	0.097 U	0.097 U	0.097 U	0.097 U	0.097 U	0.097 U	0.097 U	0.097 U	0.097 U	0.097 U	0.097 U	0.097 U	0.097 U	0.097 U
CP27	CP27 SB053	10/18/2011	Regular	12	18	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U

Table 5-7. Subsurface Soil Data Statistical Summary
Former Cape Poge Little Neck Bomb Target Area of Investigation

Constituent	Human Health Screening Criterion(1) (mg/kg)	Ecological Screening Criterion(2) (mg/kg)	Analyzed	Detected	Percent of Detection	Exceeded HHSC	Exceeded ECOSC	Percent Exceeded ECOSC	Minimum Detection (mg/kg)	Maximum Detection (mg/kg)	Maximum Detection Location
Antimony	20	0.142	25	3	12	0	0	0	0.015	0.072	CP11 SB16B
Copper	3100	5.4	25	25	100	0	0	0	0.69	1.7	CP12 SB018
Lead	300	0.0537	25	25	100	0	25	100	2.4	17	CP11 SB16B
Nickel	20	13.6	25	25	100	0	0	0	0.94	4.4	CP12 SB018, CP16 SB028
Zinc	2500	6.62	25	25	100	0	15	60	5.5	11	CP08 SB010, CP08 SB011, CP11 SB016B
1,3,5-Trinitrobenzene	2200	0.376	25	0	0	0	0	0	n/a	n/a	n/a
1,3-Dinitrobenzene	6.1	0.073	25	0	0	0	0	0	n/a	n/a	n/a
2,4,6-Trinitrotoluene	19	6.4	25	0	0	0	0	0	n/a	n/a	n/a
2,4-Dinitrotoluene	0.7	1.28	25	0	0	0	0	0	n/a	n/a	n/a
2,6-Dinitrotoluene	61	0.0328	25	0	0	0	0	0	n/a	n/a	n/a
2-Amino-4,6-dinitrotoluene	150	10	25	0	0	0	0	0	n/a	n/a	n/a
2-Nitrotoluene	2.9	9.9	25	0	0	0	0	0	n/a	n/a	n/a
3-Nitrotoluene	2.9	12	25	0	0	0	0	0	n/a	n/a	n/a
4-Amino-2,6-dinitrotoluene	150	3.6	25	0	0	0	0	0	n/a	n/a	n/a

Table 5-7. Subsurface Soil Data Statistical Summary (continued)
Former Cape Poge Little Neck Bomb Target Area of Investigation

Constituent	Human Health Screening Criterion[1] (mg/kg)	Ecological Screening Criterion[2] (mg/kg)	Analyzed	Detected	Percent of Detection	Exceeded HHSC	Exceeded ECOSC	Percent Exceeded ECOSC	Minimum Detection (mg/kg)	Maximum Detection (mg/kg)	Maximum Detection Location
4-Nitrotoluene	30	22	25	0	0	0	0	0	n/a	n/a	n/a
HMX	1	27	25	0	0	0	0	0	n/a	n/a	n/a
Nitrobenzene	4.8	1.31	25	0	0	0	0	0	n/a	n/a	n/a
Nitroglycerin	6.1	71	25	0	0	0	0	0	n/a	n/a	n/a
PETN	120	100	25	0	0	0	0	0	n/a	n/a	n/a
RDX	1	7.5	25	0	0	0	0	0	n/a	n/a	n/a
Tetryl	240	0.99	25	0	0	0	0	0	n/a	n/a	n/a

Notes:

(1) Criteria for human health were identified as the lower of 1) U.S. Environmental Protection Agency Regional Screening Level (residential selected as the most stringent) 2) Massachusetts Department of Environmental Protection Method 1 Soil Standard (SI value selected for the greatest stringency).

(2) Criteria for ecological were identified using the lower of 1) U.S. Environmental Protection Agency Ecological Soil Screening Level (lowest of avian, mammalian, plant or invertebrate) 2) Region 5 Ecological Screening Level 3) Region 4 Ecological Screening Value.

ECOSC - Ecological Screening Criterion

HHSC - Human Health Screening Criterion
mg/kg - milligrams per kilogram
n/a – not applicable
HMX - 1,3,5,7-tetranitro-1,3,5,7-tetrazocine
RDX - 1,3,5-trinitro-1,3,5-triazine
PETN - pentaerythrite tetranitrate

5.2.2 Sediment

5.2.2.1 During the RI, 16 sediment sample locations were identified and samples were collected from depth intervals of 0 to 6 in. bgs and 0 to 12 in. bgs. Analytical results from sediment sampling are presented in Table 5-8. A statistical summary of sediment data collected at the site is presented in Table 5-9. Sediment sample locations in relation to the shellfish suitability areas are presented on Figure 5-5. Sediment samples were collected in areas where softshell clams, quahogs, and bay scallops are regularly harvested. Analytical Laboratory Reports are included in Appendix D. A summary of the results is presented below.

Metals

5.2.2.2 Metals were analyzed in sediment samples collected at the AOI. Antimony was detected at two sample locations, copper was detected at 15 sample locations, while lead, nickel, and zinc were detected at each sediment sample location. No metals were detected at concentrations exceeding human health or ecological screening criterion.

Explosives

5.2.2.3 Explosives were analyzed in sediment samples; however, no explosives compounds were detected in sediments.

5.2.3 Groundwater

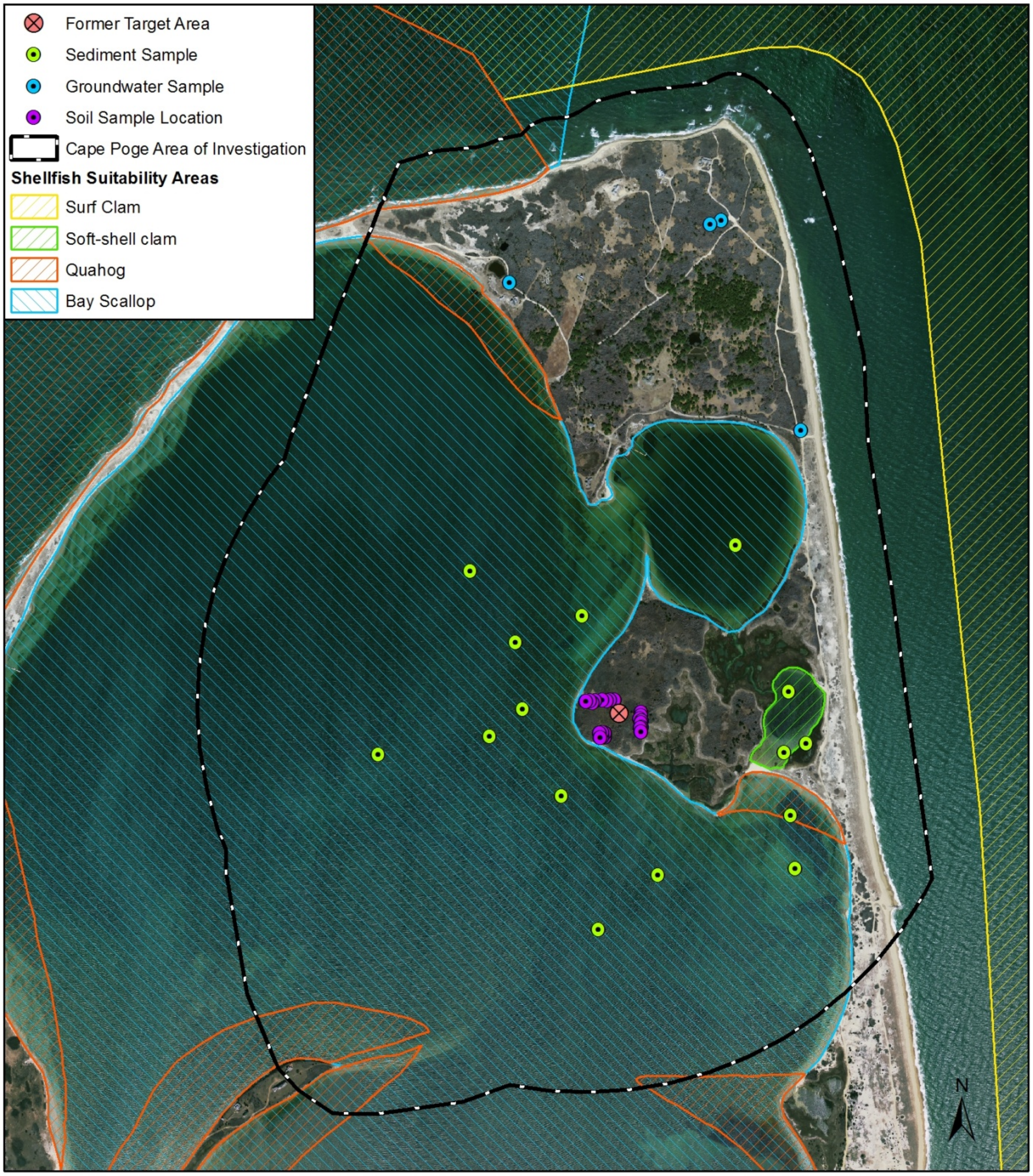
5.2.3.1 Groundwater samples were collected from three sample locations at Cape Poge, north of Shear Pen Pond. Analytical results from groundwater sampling are presented in Table 5-10. A statistical summary of groundwater data collected at the site is presented in Table 5-11. Groundwater sample locations are presented on Figure 5-4. Analytical Laboratory Reports are included in Appendix D. A summary of the results is presented below.

Metals

5.2.3.2 Antimony was not detected in groundwater samples collected at the AOI. Copper and lead were detected at the public access well adjacent to the Cape Poge Lighthouse. Nickel and zinc were detected at each of the three sample locations. No metals were detected at concentrations above human health groundwater screening criterion.

Explosives

5.2.3.3 Explosives were analyzed in groundwater samples; however, no explosives compounds were detected in groundwater.



US Army Corps of Engineers

FIGURE 5-5

Shellfish Suitability Areas and MC Sampling Locations - Former Cape Poge Little Neck Bomb Target Area of Investigation, Martha's Vineyard, MA

0 500 1,000 2,000 3,000 Feet
0 200 400 600 800 Meters

UXB amec

NOTES:
2009 aerial imagery and shellfish location data source: MassGIS

11/09/2012
Rev:
Cape_Poge_Shellfish_Areas_MC_Sampling_Remedial_Inv_Rpt.mxd
Drawn: JBO
Chk: DMS
PROJ: 562910000

Table 5-8. Sediment Sample Results Summary
Former Cape Poge Little Neck Bomb Target Area of Investigation

Location ID	Sample ID	Sample Date	Sample Type	Sample Depth Interval (inches)	Metals by 6020A									
					Antimony		Copper		Lead		Nickel		Zinc	
Human Health Screening Criterion[1]					NA		NA		NA		NA		NA	
Ecological Screening Criterion[2]					2		16		30.2		15.9		121	
Results are presented in milligrams per kilogram (mg/kg)														
CP44	CP44 SD014	11/1/2011	Regular	0-12	0.22	U	**5.4**		**0.9**		**0.69**		**2.9**	
CP32	CP32 SD001	10/22/2011	Regular	0-6	**0.02**	**J**	**4.4**	**J**	**6.3**		**4.8**	**J**	**17**	
CP33	CP33 SD002	10/22/2011	Regular	0-6	**0.017**	**J**	**0.49**	**J**	**1.2**		**0.98**	**J**	**2.8**	**J**
CP34	CP34 SD003	10/22/2011	Regular	0-6	0.26	U	**0.66**	**J**	**1.2**		**0.63**	**J**	**2.5**	**J**
CP35	CP35 SD004	10/22/2011	Regular	0-6	0.21	U	**0.47**	**J**	**0.88**		**0.67**	**J**	**2.4**	**J**
CP36	CP36 SD005	10/22/2011	Regular	0-6	0.26	U	**0.51**	**J**	**1.8**		**0.83**	**J**	**2.6**	**J**
CP37	CP37 SD006	10/22/2011	Regular	0-6	0.22	U	**0.4**	**J**	**0.92**		**0.41**	**J**	**4.3**	
CP38	CP38 SD007	10/22/2011	Regular	0-6	0.25	U	**0.53**	**J**	**1.2**		**0.61**	**J**	**2.6**	**J**
CP39	CP39 SD008	10/22/2011	Regular	0-6	0.21	U	**0.43**	**J**	**1.1**		**0.8**	**J**	**2.4**	**J**
CP40	CP40 SD009	10/22/2011	Regular	0-6	0.23	U	**0.39**	**J**	**1.2**		**0.69**	**J**	**2.1**	**J**
CP41	CP41 SD010	10/22/2011	Regular	0-6	0.25	U	**0.47**	**J**	**0.94**	**J**	**0.78**	**J**	**2.6**	**J**
CP41	CP41 SD011	10/22/2011	FD	0-6	0.23	U	**0.47**	**J**	**1.5**	**J**	**0.86**	**J**	**2.7**	**J**
CP42	CP42 SD012	10/22/2011	Regular	0-6	0.22	U	**0.48**	**J**	**1.2**		**1.1**	**J**	**2.6**	**J**
CP43	CP43 SD013	10/22/2011	Regular	0-6	0.23	U	**0.34**	**J**	**0.8**		**0.55**	**J**	**2.4**	**J**
CP45	CP45 SD015	11/1/2011	Regular	0-12	0.2	U	0.38	U	**0.85**		**0.56**		**1.7**	**J**
CP45	CP45 SD016	11/1/2011	Regular	0-12	0.21	U	**0.67**	**J**	**1.2**		**0.77**		**3.5**	
CP46	CP46 SD017	11/1/2011	Regular	0-12	0.21	U	**1.2**	**J**	**2.1**		**1.5**		**4.1**	

Notes:

[1] Sediment Criteria are generally for protection of ecological resources. Soil criteria can be used as conservative human health screening levels.

[2] Criteria for ecological endpoints were identified as the lowest of 1) Region 5 Ecological Screening Level 2) Region 3 Freshwater Screening Benchmark 3) Massachusetts Department of Environmental Protection Freshwater Sediment Screening Benchmarks 4) Region 6 Toxicity Reference Values 5) Los Alamos National Laboratory ECORISK Database Release 2.5 (October, 2010) 5) Region 4 Ecological Screening Value.

Acronyms

FD - field duplicate
NA - not available
J - quantitation estimated
U - not detected
UJ - not detected, quantitation estimated

Table 5-9. Sediment Sample Results Summary
Former Cape Poge Little Neck Bomb Target Area of Investigation

Location ID	Sample ID	Sample Date	Sample Type	Sample Depth Interval (inches)		Explosives by 8321B																															
						1,3,5-Trinitrobenzene		1,3-Dinitrobenzene		2,4,6-Trinitrotoluene		2,4-Dinitrotoluene		2,6-Dinitrotoluene		2-Amino-4,6-dinitrotoluene		2-Nitrotoluene		3-Nitrotoluene		4-Amino-2,6-dinitrotoluene		4-Nitrotoluene		HMX		Nitrobenzene		Nitroglycerin		PETN		RDX		Tetryl	
Human Health Screening Criterion(1)						NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA	
Ecological Screening Criterion(2)						121		0.01		0.24		0.009		9.2		0.014		0.04		7		5.6		4.9		1.9		4.06		0.013		100		0.47		0.145	
Results are presented in milligrams per kilogram (mg/kg)																																					
CP32	CP32 SD001	10/22/2011	Regular	0	6	0.094	U	0.094	U	0.094	U	0.094	U	0.094	U	0.094	U	0.094	U	0.094	U	0.094	U	0.094	U	0.094	U	0.094	U	0.094	U	0.094	U	0.094	U	0.094	U
CP33	CP33 SD002	10/22/2011	Regular	0	6	0.091	U	0.091	U	0.091	U	0.091	U	0.091	U	0.091	U	0.091	U	0.091	U	0.091	U	0.091	U	0.091	U	0.091	U	0.091	U	0.091	U	0.091	U	0.091	U
CP34	CP34 SD003	10/22/2011	Regular	0	6	0.095	U	0.095	U	0.095	U	0.095	U	0.095	U	0.095	U	0.095	U	0.095	U	0.095	U	0.095	U	0.095	U	0.095	U	0.095	U	0.095	U	0.095	U	0.095	U
CP35	CP35 SD004	10/22/2011	Regular	0	6	0.093	U	0.093	U	0.093	U	0.093	U	0.093	U	0.093	U	0.093	U	0.093	U	0.093	U	0.093	U	0.093	U	0.093	U	0.093	U	0.093	U	0.093	U	0.093	U
CP36	CP36 SD005	10/22/2011	Regular	0	6	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U
CP37	CP37 SD006	10/22/2011	Regular	0	6	0.098	U	0.098	U	0.098	U	0.098	U	0.098	U	0.098	U	0.098	U	0.098	U	0.098	U	0.098	U	0.098	U	0.098	U	0.098	U	0.098	U	0.098	U	0.098	U
CP38	CP38 SD007	10/22/2011	Regular	0	6	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U
CP39	CP39 SD008	10/22/2011	Regular	0	6	0.098	U	0.098	U	0.098	U	0.098	U	0.098	U	0.098	U	0.098	U	0.098	U	0.098	U	0.098	U	0.098	U	0.098	U	0.098	U	0.098	U	0.098	U	0.098	U
CP40	CP40 SD009	10/22/2011	Regular	0	6	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U
CP41	CP41 SD010	10/22/2011	Regular	0	6	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U
CP41	CP41 SD011	10/22/2011	FD	0	6	0.095	U	0.095	U	0.095	U	0.095	U	0.095	U	0.095	U	0.095	U	0.095	U	0.095	U	0.095	U	0.095	U	0.095	U	0.095	U	0.095	U	0.095	U	0.095	U
CP42	CP42 SD012	10/22/2011	Regular	0	6	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U	0.096	U
CP43	CP43 SD013	10/22/2011	Regular	0	6	0.099	U	0.099	U	0.099	UJ	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U	0.099	U
CP44	CP44 SD014	11/1/2011	Regular	0	12	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U
CP45	CP45 SD015	11/1/2011	Regular	0	12	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U
CP45	CP45 SD016	11/1/2011	Regular	0	12	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U
CP46	CP46 SD017	11/1/2011	Regular	0	12	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U	0.097	U

Notes:

(1) Sediment Criteria are generally for protection of ecological resources. Soil criteria can be used as conservative human health screening levels.

(2) Criteria for ecological endpoints were identified as the lowest of 1) Region 5 Ecological Screening Level 2) Region 3 Freshwater Screening Benchmark 3) Massachusetts Department of Environmental Protection Freshwater Sediment Screening Benchmarks 4) Region 6 Toxicity Reference Values 5) Los Alamos National Laboratory ECORISK Database Release 2.5 (October, 2010) 5) Region 4 Ecological Screening Value.

Acronyms

FD - field duplicate
J - quantitation estimated
UJ - not detected, quantitation estimated
NA - not available
U - not detected

Table 5-10. Sediment Data Statistical Summary
Former Cape Poge Little Neck Bomb Target Area of Investigation

Constituent	HHSC[(1)] (mg/kg)	ECOSC[(2)] (mg/kg)	Analyzed	Detected	Percent of Detection	Exceeded HHSC	Exceeded ECOSC	Percent Exceeded ECOSC	Minimum Detection (mg/kg)	Maximum Detection (mg/kg)	Maximum Detection Location
Antimony	n/a	2	17	2	12	0	0	0	0.017	0.02	CP32 SD001
Copper	n/a	16	17	16	94	0	0	0	0.34	5.4	CP44 SD014
Lead	n/a	30.2	17	17	100	0	0	0	0.8	6.3	CP32 SD001
Nickel	n/a	15.9	17	17	100	0	0	0	0.41	4.8	CP32 SD001
Zinc	n/a	121	17	17	100	0	0	0	1.7	17	CP32 SD001
1,3,5-Trinitrobenzene	n/a	0.24	17	0	0	0	0	0	n/a	n/a	n/a
1,3-Dinitrobenzene	n/a	0.00861	17	0	0	0	0	0	n/a	n/a	n/a
2,4,6-Trinitrotoluene	n/a	9.2	17	0	0	0	0	0	n/a	n/a	n/a
2,4-Dinitrotoluene	n/a	0.0144	17	0	0	0	0	0	n/a	n/a	n/a
2,6-Dinitrotoluene	n/a	0.0398	17	0	0	0	0	0	n/a	n/a	n/a
2-Amino-4,6-dinitrotoluene	n/a	34	17	0	0	0	0	0	n/a	n/a	n/a
2-Nitrotoluene	n/a	28	17	0	0	0	0	0	n/a	n/a	n/a
3-Nitrotoluene	n/a	24	17	0	0	0	0	0	n/a	n/a	n/a
4-Amino-2,6-dinitrotoluene	n/a	9.5	17	0	0	0	0	0	n/a	n/a	n/a
4-Nitrotoluene	n/a	4.06	17	0	0	0	0	0	n/a	n/a	n/a
HMX	n/a	0.47	17	0	0	0	0	0	n/a	n/a	n/a
Nitrobenzene	n/a	0.145	17	0	0	0	0	0	n/a	n/a	n/a
Nitroglycerin	n/a	1700	17	0	0	0	0	0	n/a	n/a	n/a
PETN	n/a	1400	17	0	0	0	0	0	n/a	n/a	n/a
RDX	n/a	0.013	17	0	0	0	0	0	n/a	n/a	n/a
Tetryl	n/a	100	17	0	0	0	0	0	n/a	n/a	n/a

Notes:

(1) Sediment Criteria are generally for protection of ecological resources. Soil criteria can be used as conservative human health screening levels.

(2) Criteria for ecological endpoints were identified as the lowest of 1) Region 5 Ecological Screening Level 2) Region 3 Freshwater Screening Benchmark 3) Massachusetts Department of Environmental Protection Freshwater Sediment Screening Benchmarks 4) Region 6 Toxicity Reference Values 5) Los Alamos National Laboratory ECORISK Database Release 2.5 (October, 2010) 5) Region 4 Ecological Screening Value.

ECOSC - Ecological Screening Criterion
HHSC - Human Health Screening Criterion
mg/kg - milligrams per kilogram
n/a – not applicable or not available
HMX - 1,3,5,7-tetranitro-1,3,5,7-tetrazocine
RDX - 1,3,5-trinitro-1,3,5-triazine
PETN - pentaerythrite tetranitrate

Table 5-11. Groundwater Sampling Results Summary
Former Cape Poge Little Neck Bomb Target Area of Investigation

Location ID	Sample ID	Sample Date	Sample Type	Sample Depth Interval (inches)	Metals by 6020A				
					Antimony	Copper	Lead	Nickel	Zinc
Human Health Screening Criterion[1]					6	1300	10	100	11000
Ecological Screening Criterion[2]					NA	NA	NA	NA	NA
Results are presented in micrograms per liter (µg/L)									
CP29	CP29 GW002	11/1/2011	Regular	28-32	6 U	2 U	3 U	**4.5**	**5 J**
CP31	CP31 GW004	11/1/2011	Regular	8-12	6 U	2 U	3 U	**1.7 J**	**3.3 J**
CP31	CP31 GW005	11/1/2011	FD	8-12	6 U	2 U	3 U	**1.5 J**	**2.7 J**
CP47	CP47 GW015	11/1/2011	Regular	27-32	6 U	**42**	**3.1**	**2.1 J**	**390**

Notes:

(1) Criteria for human health were identified as the lower of 1) U.S. Environmental Protection Agency Maximum Contaminant Level, 2) U.S. Environmental Protection Agency Regional Screening Level, 3) Massachusetts Department of Environmental Protection Method 1 Groundwater Standards (GW1 value selected for the greatest stringency).

(2) U.S. Environmental Protection Agency ecological criteria for groundwater were not identified. Massachusetts Department of Environmental Protection GW-3 standards are intended to protect surface water, so selecting the lowest groundwater standard is protective of surface water.

Acronyms

FD - field duplicate

NA - not available

J - quantitation estimated

U - not detected

Table 5-11. Groundwater Sampling Results Summary (continued)
Former Cape Poge Little Neck Bomb Target Area of Investigation

Location ID	Sample ID	Sample Date	Sample Type	Sample Depth Interval	Explosives by 8321B															
					1,3,5-Trinitrobenzene	1,3-Dinitrobenzene	2,4,6-Trinitrotoluene	2,4-Dinitrotoluene	2,6-Dinitrotoluene	2-Amino-4,6-dinitrotoluene	2-Nitrotoluene	3-Nitrotoluene	4-Amino-2,6-dinitrotoluene	4-Nitrotoluene	HMX	Nitrobenzene	Nitroglycerin	PETN	RDX	Tetryl
Human Health Screening Criterion[1]					1100	3.7	2.2	0.22	37	73	0.31	3.7	73	4.2	200	0.12	3.7	17	0.61	150
Ecological Screening Criterion[2]					NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Results are presented in micrograms per liter (µg/L)																				
CP29	CP29 GW002	11/1/2011	Regular	28-32	0.098 U	0.098 U	0.098 U	0.098 U	0.098 U	0.098 U	0.098 U	0.098 U	0.098 U	0.098 U	0.49 U	0.098 U	0.14 U	0.098 U	0.098 U	0.098 U
CP31	CP31 GW004	11/1/2011	Regular	8-12	0.12 U	0.12 U	0.12 U	0.12 U	0.12 U	0.12 U	0.12 U	0.12 U	0.12 U	0.12 U	1.2 U	0.12 U	0.17 U	0.12 U	0.12 U	0.12 U
CP31	CP31 GW005	11/1/2011	FD	8-12	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	1.1 U	0.11 U	0.16 U	0.11 U	0.11 U	0.11 U
CP47	CP47 GW015	11/1/2011	Regular	27-32	0.096 U	0.096 U	0.096 U	0.096 U	0.096 U	0.096 U	0.096 U	0.096 U	0.096 U	0.096 U	0.48 U	0.096 U	0.13 U	0.096 U	0.096 U	0.096 U

Notes:

[1] Criteria for human health were identified as the lower of 1) U.S. Environmental Protection Agency Maximum Contaminant Level, 2) U.S. Environmental Protection Agency Regional Screening Level, 3) Massachusetts Department of Environmental Protection Method 1 Groundwater Standards (GW1 value selected for the greatest stringency).

[2] U.S. Environmental Protection Agency ecological criteria for groundwater were not identified. Massachusetts Department of Environmental Protection GW-3 standards are intended to protect surface water, so selecting the lowest groundwater standard is protective of surface water.

Acronyms

FD - field duplicate

NA - not available

U - not detected

Table 5-12. Groundwater Data Statistical Summary
Former Cape Poge Little Neck Bomb Target Area of Investigation

Constituent	HHSC[1] (µg/L)	ECOSC[2] (µg/L)	Analyzed	Detected	Percent of Detection	Exceeded HHSC	Exceeded ECOSC	Percent Exceeded ECOSC	Minimum Detection (µg/L)	Maximum Detection (µg/L)	Maximum Detection Location
Antimony	6	n/a	4	0	0	--	--	--	--	--	--
Copper	1300	n/a	4	1	25	0	0	0	42	42	CP47 GW15
Lead	10	n/a	4	1	25	0	0	0	3.1	3.1	CP47 GW15
Nickel	100	n/a	4	4	100	0	0	0	1.5	4.5	CP29 GW002
Zinc	11000	n/a	4	4	100	0	0	0	2.7	390	CP47 GW15
1,3,5-Trinitrobenzene	1100	n/a	4	0	0	0	0	0	n/a	n/a	n/a
1,3-Dinitrobenzene	3.7	n/a	4	0	0	0	0	0	n/a	n/a	n/a
2,4,6-Trinitrotoluene	2.2	n/a	4	0	0	0	0	0	n/a	n/a	n/a
2,4-Dinitrotoluene	0.22	n/a	4	0	0	0	0	0	n/a	n/a	n/a
2,6-Dinitrotoluene	37	n/a	4	0	0	0	0	0	n/a	n/a	n/a
2-Amino-4,6-dinitrotoluene	73	n/a	4	0	0	0	0	0	n/a	n/a	n/a
2-Nitrotoluene	0.31	n/a	4	0	0	0	0	0	n/a	n/a	n/a
3-Nitrotoluene	3.7	n/a	4	0	0	0	0	0	n/a	n/a	n/a
4-Amino-2,6-dinitrotoluene	73	n/a	4	0	0	0	0	0	n/a	n/a	n/a
4-Nitrotoluene	4.2	n/a	4	0	0	0	0	0	n/a	n/a	n/a
HMX	200	n/a	4	0	0	0	0	0	n/a	n/a	n/a
Nitrobenzene	0.12	n/a	4	0	0	0	0	0	n/a	n/a	n/a
Nitroglycerin	3.7	n/a	4	0	0	0	0	0	n/a	n/a	n/a
PETN	17	n/a	4	0	0	0	0	0	n/a	n/a	n/a
RDX	0.61	n/a	4	0	0	0	0	0	n/a	n/a	n/a
Tetryl	150	n/a	4	0	0	0	0	0	n/a	n/a	n/a

Notes:

(1) Criteria for human health were identified as the lower of 1) U.S. Environmental Protection Agency Maximum Contaminant Level, 2) U.S. Environmental Protection Agency Regional Screening Level, 3) Massachusetts Department of Environmental Protection Method 1 Groundwater Standards (GW1 value selected for the greatest stringency).

(2) U.S. Environmental Protection Agency ecological criteria for groundwater were not identified. Massachusetts Department of Environmental Protection GW-3 standards are intended to protect surface water, so selecting the lowest groundwater standard is protective of surface water.

ECOSC - Ecological Screening Criterion
HHSC - Human Health Screening Criterion
µg/L - micrograms per kilogram
n/a – not applicable or not available
HMX - 1,3,5,7-tetranitro-1,3,5,7-tetrazocine
RDX - 1,3,5-trinitro-1,3,5-triazine
PETN - pentaerythrite tetranitrate

5.3 Revised Conceptual Site Model

5.3.1 The preliminary CSM presented in Section 3.1 was reviewed and revised based upon the results of MEC and MC characterization activities. The key findings of the RI include:

- The target area was confirmed through geophysical and intrusive investigations.
- The residential area north of Shear Pen Pond does not contain MEC or MD.
- The beach and ocean areas do not contain MEC or MD.
- MC sampling indicated that human health screening criterion were not exceeded in any media.
- Antimony, lead, and zinc were found in concentrations exceeding ecological screening criterion in soil.

5.3.2 These findings build upon data gathered from historical records, previous investigation, removal actions, and interviews with long-term residents and former military personnel. Table 5-12 summarizes the revised CSM including facility, physical, release, land use and exposure, and ecological profiles for MEC and MCs.

Table 5-13. Revised Conceptual Site Model Summary
Former Cape Poge Little Neck Bomb Target Area of Investigation

Facility Profile	Physical Profile	Release Profile	Land Use and Exposure Profile	Ecological Profile
Facility Description: - Approximately 800 acres. (1) - Located on the Little Neck peninsula, which is bound to the north by Shear Pen Pond, to the west and south by Cape Poge Bay, and to the east by a small strip of land that separates the site from the Atlantic Ocean. - No permanent structures were constructed by the U.S. Navy at the site. (2) - Available records do not specify the precise layout and usage the target; however, the standard range cell consisted of a circle with a radius of 1,500 feet (ft) from the target center and consisting of 162 acres. (2) **Site History:** - The site was used for day and night practice bombing activities from approximately July 1944 until approximately March 1947. (2) - Records do not indicate that the property was ever used to store, transport, treat, or dispose of the associated munitions used on property. (2) **Munitions Potentially Used:** - 100-Pound Practice Bomb, Mark (MK)15-series; - Miniature Practice Bombs, AN-MK 5 Mod 1, AN-MK 23, AN-MK43; - Signal Practice Bomb, MK4 Mods 3 & 4; - Signal Practice Bomb, MK6 Mod 0; and, - Flare, Aircraft, Parachute, M26 & AN-M26. (2)	**Site Characteristics:** - Approximately 153 acres of land - Approximately 83 acres of beach - Approximately 500 acres of inland water - Approximately 64 acres of ocean (1) **Topography:** - Relatively flat maritime shrub thicket, salt marsh, and maritime beach. (1) **Vegetation:** - Salt Marsh Cordgrass, Salt Meadow Cordgrass, Black Grass, Salt Marsh Fleabane, and glassworts, with Marsh Elder and Groundsel Tree along their fringes. (1) **Surface Water:** - Surface water is located within marshes and mudflats. - Surface water runoff is not expected in upland areas. **Soils:** - Soils located on the sand dunes consist of medium to coarse sands and are excessively drained. - Soils located in marshes consist of a dense layer of organic material over fine grained sand and are very poorly drained. **Geology:** - Glacial deposits consisting of recent beach and marsh sediments, glacial deposits, interglacial deposits, and glacially deformed ancient coastal plain sediments. (2) - Bedrock is encountered at approximately 500 ft below ground Surface (bgs) and is comprised of metamorphic and igneous rocks. (2) **Hydrogeology:** - Depth of groundwater ranges from 0 to greater than 6 ft bgs. - Groundwater on Martha's Vineyard is primarily discharged directly to the ocean and surrounding bays. (2) **Meteorology:** - Average Annual Rainfall = 46 inches per year. (2)	**Contaminants of Potential Concern:** - Munitions and explosives of concern (MEC) - Antimony, lead, and zinc. **Media of Potential Concern:** - Surface and subsurface soil, sediment, and groundwater **Confirmed MEC/MD Locations:** - During the 2009 Time-Critical Removal Action, 127 Munitions Debris (MD) items were identified and removed. Items included AN-MK23 and AN-MK5 practice bombs. These items were heavily concentrated along the western edge of Little Neck. Additional debris items were identified in the central and southern marsh area as well as along shoreline to the north and south of Little Neck. (3) - During the 2010-2011 Remedial Investigation, nature and extent of MEC and MD was delineated. 88 MEC items and 325 MD items were recovered. Recovered items included intact and expended AN-MK23 3-pound practice bombs and the remnants of a 100-pound practice bomb. These items were concentrated on Little Neck around the historic bomb target location. **MC Results:** - During the 2010-2011 RI, surface soil, subsurface soil, sediment, and groundwater samples were collected within the Area of Investigation (AOI). Sample results indicate that MC concentrations do not exceed residential direct contact screening criterion. Antimony, lead, and zinc were detected in soil samples at concentrations that exceeded ecological screening criterion. **Identified Pathways:** - Based upon sampling results, munitions constituents (MCs) have not been released at concentrations above human health screening criterion. Antimony, lead, and zinc were detected in soil at concentration above ecological screening criterion. Results indicate that adsorption of MCs to surface soil particles have been the primary mechanism influencing the extent of MCs in the environment. - MEC and MD items located in Shear Pen Pond and Cape Poge Bay are subject to transport via dredging activities.	**Current Landowners:** - The Trustees of Reservations, the Commonwealth of Massachusetts (inland and coastal waters), and private landowners. (1) **Current Land Use:** - Part of the Cape Poge Wildlife Refuge. (2) - Currently, the AOI remains mostly undeveloped; however, there are several single-family residential homes located in the northern portion of Cape Poge. - The public has limited access, which is defined as some access to the former range, but that access doesn't involve any digging. (2) - Common property activities include, but are not limited to, sunbathing, swimming, four-wheel driving, picnicking, hiking, fishing, clamming, scalloping, crabbing and visiting the lighthouse. (2) **Future Land Use:** - It is anticipated that the future land use will remain the same. **Resource Identification:** - Based on information in the Massachusetts Department of Environmental Protection Geographic Information System, the area does not qualify as a non-potable use area and use of groundwater as potable supply must be assumed. **Potential Receptors:** - Potential receptors associated with current and future land use include residents, trespassers/recreational users, and site workers for MEC and MCs. Biota is also a potential receptor for MCs. - There is concern that visitors have been moving bombs and concern over public digs in mudflats for clams. (1)	**Property Description:** - The site consists of upland sand dunes, lower areas consisting of marshes, mudflats, and inland waters. - The present land use includes primarily recreational use with little disturbance likely. **Potential Ecological Receptors:** - Inland and plant species, fish, birds, insects, and mammals that inhabit or migrate through the site. Associated threatened and endangered species are included. **Threatened and Endangered Species:** - There are approximately 37 federal/state threatened, endangered, and/or special concern species that could be present at the site. (1) **Relationship of Munitions Debris to Habitat:** - Munitions items may be located within and/or adjacent to habitat areas.

Notes:

(1) UXB International, Inc., 2011. *Final Revision 1, Remedial Investigation Work Plan, Former Cape Poge Little Neck Bomb Target MRS, Former Moving Target Machine Gun Range at South Beach MRS, & Tisbury Great Pond MRS, Martha's Vineyard, Massachusetts.* January.

(2) U.S. Army Corps of Engineers St. Louis District, 2009b. *Draft Report, Preliminary Assessment, Cape Poge Little Neck Bomb Target Site, Chappaquiddick Island, MA, FUDS Property – D01MA0595.* February.

(3) U.S. Army Corps of Engineers, 2010. *Draft Final Site Specific Final Report For The Time Critical Removal Action (TCRA) at Former Cape Poge Little Neck Bomb Target Site, Chappaquiddick Island, Dukes County, Massachusetts, and Former Moving Target Machine Gun Range at South Beach, Martha's Vineyard, Edgartown, Massachusetts.* January.

6.0 CONTAMINANT FATE AND TRANSPORT

6.0.1 The source of MEC and MCs are evaluated in relation to historic and current site activities and processes, lateral and vertical distribution, and the physical and chemical properties that act to concentrate or degrade the mass and concentration of the chemicals in the environment. Constituent fate and transport are also affected by the physical and chemical properties of MEC and MCs, the nature and extent of the release, as well as physical and chemical properties of the medium in which MEC and MCs are present. For example, MEC may be found on the surface or buried in the subsurface; however, it is possible for natural processes to result in the movement, relocation, or unearthing of MEC, increasing the chance of subsequent exposure to receptors.

6.1 Fate and Transport Processes for MEC

6.1.1 As presented in Section 3.1.3, the ultimate fate of MEC items within the AOI is governed by various physical factors/transport processes that include:

- Transport by ocean currents;
- Transport via dredging operations within Shear Pen Pond and Cape Poge Bay;
- Natural erosion of soil by wind and water exposing buried MEC items; and,
- Transport via removal or relocation of MEC.

6.1.2 The results of the geophysical and intrusive investigations conducted as part of this RI and historical investigations indicate that MEC items are concentrated in the western portion of Little Neck, near the historical bomb target location, and within Cape Poge Bay, near the western shoreline of Little Neck. No MEC or MD items were recovered within ocean transects; therefore, all of the transport processes listed above, with the exception of transport by ocean currents, are potential transport processes that could affect the ultimate fate of MEC items.

6.2 Fate and Transport Processes for MCs

6.2.1 As discussed in Section 3.1.3, the fate and transport of metals in the environment is governed by a number of interrelated processes, including oxidation/reduction conditions, the degree of inorganic and organic complexation, and pH conditions of the soil and groundwater. Adsorption of metal cations has been correlated with such soil properties as pH, redox potential, clay and/or soil organic matter content, CEC, iron and manganese oxides, and calcium carbonate content. Typically, as these soil properties increase, the adsorption capacity of cationic metals will also increase. Based upon the fate and transport processes of cationic metals as well as the distribution and concentration of the evaluated metals, it appears that these metals have adsorbed to soil particles and are bound to surface soil and near surface soil.

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7.0 MEC HAZARD ASSESSMENT AND MC BASELINE RISK ASSESSMENT

7.1 MEC Hazard Assessment

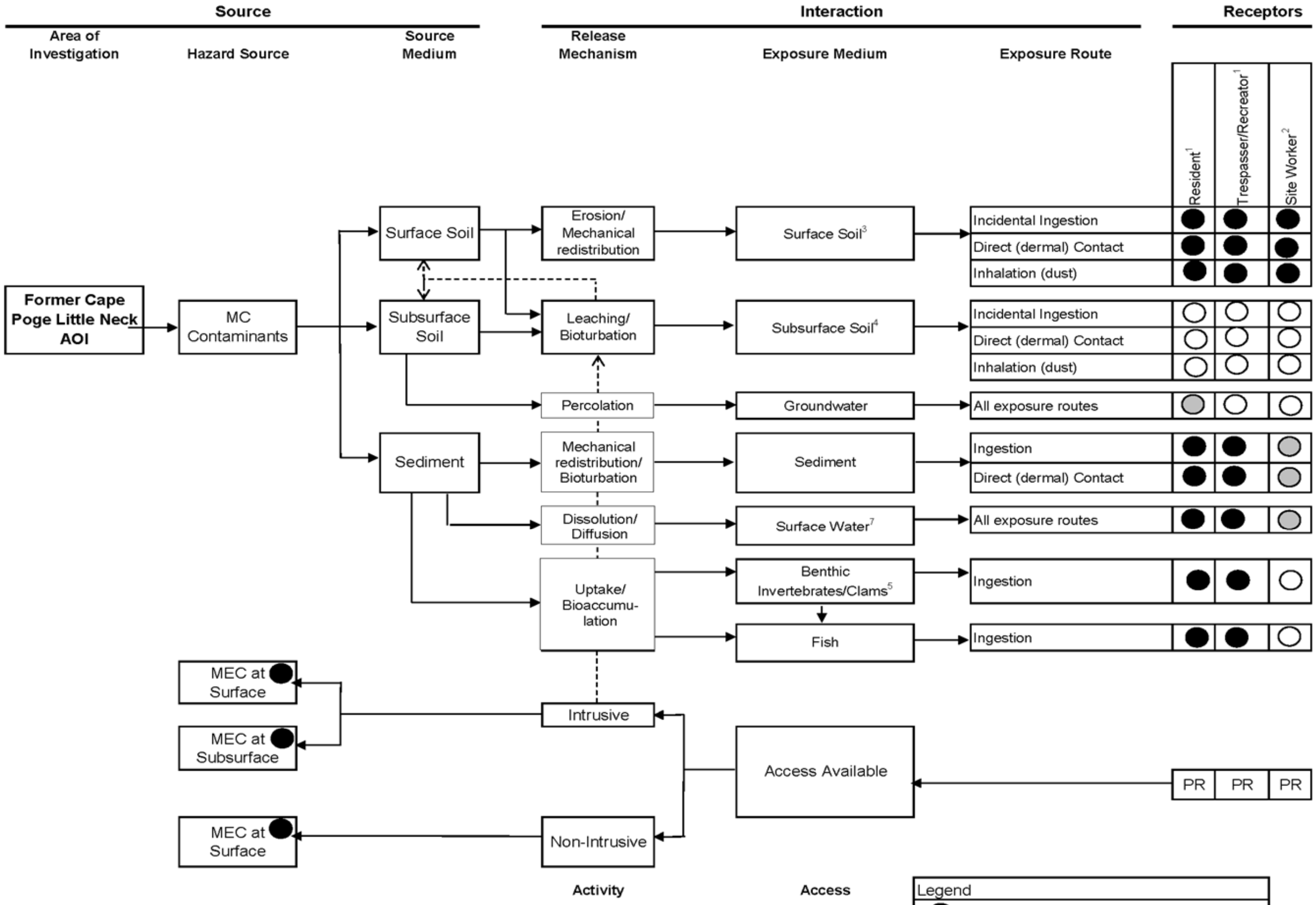
7.1.0.1 In the RI phase of the CERCLA process, the MEC HA is developed to support the hazard management decision making process by analyzing site-specific information to assess existing explosives hazards. The MEC HA addresses human health and safety concerns associated with potential exposure to MEC at a site. It does not directly address environmental or ecological concerns that might be associated with MEC, including the risks associated with exposure to MCs as environmental contaminants.

7.1.0.2 An explosive hazard exists at a site if there is a potentially complete MEC exposure pathway. A potentially complete MEC exposure pathway is present any time a receptor can come near or into contact with MEC and interact with it in a manner that might result in its detonation. The three elements of a potentially complete MEC exposure pathway, which include a source of MEC, a receptor, and the potential for interaction between the MEC source and the receptor, but all three elements must be present for a potentially complete MEC exposure pathway to exist. Because MEC has been identified in surface and subsurface media and there are potential receptors that may come into contact with MEC within the AOI, the pathway for surface and subsurface media is considered complete (Figure 7-1).

7.1.0.3 The qualitative HA technique presented in this report follows the MEC HA method, which provides an assessment of the acute explosive hazards associated with remaining MEC at a site by analyzing site-specific conditions and human issues that affect the likelihood that a MEC accident will occur. The MEC HA method focuses on hazards to human receptors and does not directly address environmental or ecological concerns that might be associated with MEC. The process for conducting the MEC HA is described in the MEC HA interim guidance document (USEPA, 2008) and uses input data based on historical documentation, field observations made during this RI and previous studies and removal actions, and on the results of the intrusive investigations conducted as part of this. The MEC HA interim guidance was developed by the Technical Working Group for Hazard Assessment, which included representatives from the DoD, the U.S. Department of the Interior, the USEPA, and various states and tribes (USEPA, 2008). The DoD has encouraged the use of this method on a trial basis (DoD, 2009).

7.1.0.4 The MEC HA method reflects the basic difference between assessing acute hazards from exposure to MEC and assessing chronic environmental risks from exposure to potential contaminants, such as MCs. An explosive hazard can result in immediate injury or death and; therefore, risks from explosive hazards are evaluated either as being present or not present. If the potential for an encounter with MEC exists, then the potential that the encounter may result in

Figure 7-1. CSM for Human Exposures



Exposure Medium	Exposure Route	Resident[1]	Trespasser/Recreator[1]	Site Worker[2]
Surface Soil[3]	Incidental Ingestion	●	●	●
	Direct (dermal) Contact	●	●	●
	Inhalation (dust)	●	●	●
Subsurface Soil[4]	Incidental Ingestion	○	○	○
	Direct (dermal) Contact	○	○	○
	Inhalation (dust)	○	○	○
Groundwater	All exposure routes	◍	○	○
Sediment	Ingestion	●	●	◍
	Direct (dermal) Contact	●	●	◍
Surface Water[7]	All exposure routes	●	●	◍
Benthic Invertebrates/Clams[5]	Ingestion	●	●	○
Fish	Ingestion	●	●	○
Access Available		PR	PR	PR

Notes:

1. Includes anglers and clammers.
2. Employee of Trust or other authorized entrant for isnpection or observational purposes; no physical/intrusive activities or contact with the aquatic zone assumed.
3. Surface soil represented by soil samples collected from 0 - 2 inches and 2 - 12 inches below ground surface (bgs).
4. Subsurface soil represented by soil samples collected between 12 and 18 inches bgs.
5. Includes shellfish consumed by humans and thos servign as food sources in the food chain.

Legend

● Complete Pathway
◍ Potential Complete Pathway
○ Incomplete Pathway (not evaluated)
PR Potential Receptor
NA Pathway not applicable to the receptor

injury or death also exists. Conversely, if the potential presence of MEC at a site can be ruled out as a result of RI activities, then no explosive hazards are present and no MEC HA is necessary.

7.1.0.5 The MEC HA presented in this RI Report was conducted to characterize the baseline conditions for the AOI with regard to explosive hazards. This baseline characterization may be referenced in the subsequent FS where they may be used to provide the basis for the evaluation and implementation of effective management response alternatives.

7.1.1 Defining the Areas to be Assessed

7.1.1.1 The MEC HA is focused on each MRS at a site. However, at Cape Poge based upon the identification of MD and MEC items during previous investigations and by the public, the area of interest was expanded to encompass the current boundaries of the AOI. The MEC HA does not address underwater areas (i.e., inland water and ocean areas); therefore, this MEC HA will address 237 acres of land and beach area within Cape Poge (Figure 2-2).

7.1.2 Overview of MEC Hazard Assessment Input Factors

7.1.2.1 Under the MEC HA method, the potential hazards posed by MEC are characterized by evaluating three primary factors:

- *Severity*: the potential consequences of the effect on a human receptor should a MEC item detonate;
- *Accessibility*: the likelihood that a human receptor will be able to come into contact with a MEC item; and,
- *Sensitivity*: the likelihood that a MEC item will detonate if a human receptor interacts with it.

7.1.2.2 To complete the baseline MEC HA, various input factors are reviewed and suitable categories are selected based on historical documentation and field observations made during the RI and previous studies. These input factors include such details as "energetic material type," "site accessibility," "potential receptor contact hours," "amount of MEC," "MEC classification," and "MEC size," each of which has two or more possible categories. Each category for each of the MEC HA input factors has an assigned score that relates to the relative contributions of the different input factors to the overall MEC hazard. Scores for the categories are in multiples of five, with a total maximum possible score for all factors of 1,000 and a minimum possible score of 125. The various input factors for the MEC HA method are explained in detail in the MEC HA interim guidance document (USEPA, 2008) and are summarized in Appendix J of this report.

7.1.3 Overview of MEC Hazard Assessment Output Factors

7.1.3.1 Once the categories and scores for all input factors have been determined for the assessment area, the related scores for each category are totaled to calculate an overall MEC HA score. The total maximum possible MEC HA score for a site is 1,000 while the minimum possible score is 125. The MEC HA method describes associated "hazard levels" for these scores, which range from 1 (highest) to 4 (lowest). The basis for these hazard levels is provided in the MEC HA interim guidance document (USEPA, 2008). The output factors for the MEC HA are summarized in Appendix J.

7.1.4 Summary of Baseline MEC Hazard Assessment Characterizations

7.1.4.1 The AOI was characterized using the MEC HA method based on the results of the RI, and the historical information available from prior studies and removal actions. The results of these MEC HAs are summarized in Table 7-1. Under current conditions, the AOI received a hazard level category of 2 indicated high potential explosive hazard conditions are present at the AOI. This information will provide the baseline for any assessment of response alternatives to be conducted. Note that these total MEC HA scores and the associated hazard levels are *qualitative references only* and should not be interpreted as quantitative measures of explosive hazard.

Table 7-1. MEC HA Scoring Summary
Former Cape Poge Little Neck Bomb Target Area of Investigation

Scoring Summary		
Site ID: FUDS No. D01MA0595 (Former Cape Poge Little Neck Bomb Target Area of Investigation)	a. Scoring Summary for Current Use Activities	
Date: 4/30/2012	Response Action Cleanup: No Response Action	
Input Factor	**Input Factor Category**	**Score**
Energetic Material Type		40
Location of Additional Human Receptors	Inside the Munitions Response Site or inside the Explosives Safety Quantity Distance arc	30
Site Accessibility	Full Accessibility	80
Potential Contact Hours	100,000 to 999,999 receptor hours per year	70
Amount of munitions and explosives of concern (MEC)	Target Area	180
Minimum MEC Depth Relative to Maximum Intrusive Depth	Baseline Condition: MEC located surface and subsurface. After Cleanup: Intrusive depth overlaps with subsurface MEC	240
Migration Potential	Possible	30
MEC Classification	Unexploded Ordnance	110
MEC Size	Small	40
	Total Score	**820**
	Hazard Level Category	**2**

7.2 Munitions Response Site Prioritization Protocol

7.2.0.1 The DoD proposed the MRSPP (32 CFR Part 179) to assign a relative risk priority to each defense site in the MMRP Inventory for response activities. These response activities are based on the overall conditions at each location and taking into consideration various factors related to explosive safety and environmental hazards. The application of the MRSPP applies to all locations that:

- Are or were, owned, leased to, or otherwise possessed or used by the DoD;
- Are known to, or suspected to, contain MEC or MC; and,
- Are included in the MMRP Inventory.

7.2.0.2 Because the MRSPP worksheets are considered Draft until review by the public and undergo a Quality Assurance review by the DoD, they will be submitted as a separate deliverable from the RI Report. The public will be notified when the MRSPP is available for public review and comment. The MRSPP worksheets will be included in the information repository and administrative record for this site.

7.3 MC Baseline Human Health Risk Assessment

7.3.0.1 This HHRA has been performed in accordance with CERCLA guidelines and with consideration of additional screening levels available through the MADEP. The HHRA process is intended to provide a comprehensive assessment of potential risks to individuals that may be exposed to hazardous constituents at or from the AOI.

7.3.0.2 This HHRA was conducted consistent with appropriate portions of the guidance provided by USEPA (RAGS, Volume 1: Human Health Evaluation Manual, Parts A, D, E, and F). USEPA's risk assessment guidance describes a four-step protocol:

- Hazard Identification;
- Toxicity Assessment;
- Exposure Assessment; and,
- Risk Characterization.

7.3.0.3 This process has been completed at a screening level (Pathway Analysis Report, or PAR) to determine the need to proceed to a full quantitative HHRA. The PAR is a qualitative or semi-quantitative assessment that identifies the receptors, exposure pathways, and COPCs.

7.3.1 Hazard Identification

7.3.1.1 The Hazard Identification step of the HHRA is used to identify the COPCs in each environmental medium to which human receptors may be exposed.

7.3.2 Conceptual Site Model

7.3.2.1 Section 3.1 presents a preliminary CSM based on the identified receptors described in Section 2.2.3. The updated CSM based on the results of the RI appears in Section 5.3. The key finding that distinguished the preliminary from final CSM was the absence of MCs detected above screening levels in environmental media. However, several metals were detected. Briefly, metals associated with bombs dropped on upland soils and beaches could have adsorbed onto organic matter, if present, or leached downward through the soil into groundwater. In marsh areas, these elements would most likely have been adsorbed to the organic matter that is characteristic of soils in these areas. However, more soluble constituents could have migrated within surface water into adjacent surface water bodies. In addition, metals deposited in Shear Pen Pond and Cape Poge Bay may have been subject to direct physical transport through dredging activities.

7.3.2.2 Figure 7-1 summarizes the CSM for human exposure to media potentially impacted by the AOI. The potential exposure pathways and receptors are described further below.

7.3.3 Receptors and Pathways

7.3.3.1 Environmental media at the AOI that present a potential for human exposure are surface soil, subsurface soil, surface water, sediment, and groundwater.

7.3.3.2 The AOI is owned by TTOR, the Commonwealth of Massachusetts (inland and coastal waters), and private landowners. Although the AOI remains mostly undeveloped, there are several single-family residential homes located in the northern portion of Cape Poge. The public has access to the AOI, and activities include, but are not limited to, sunbathing, swimming, four-wheel driving, picnicking, hiking, fishing, clamming, scalloping, crabbing and visiting the lighthouse.

7.3.3.3 The following exposure pathways apply for humans:

Direct Contact with Surface Soil

7.3.3.4 Surface soils include both 0 to 2 in. incremental samples and the 2 to 12 in. discrete samples. (MADEP considers any soil within the top 3 ft to be surficial and accessible if not paved or otherwise covered). Humans who may access the AOI, local residents, area visitors, trespassers and authorized site workers, may all come into contact with surficial soil. Pathways of exposure include incidental ingestion, dermal contact, and inhalation of dust. These pathways are assumed to be complete currently and in the future. Exposure to deeper soil or directly to groundwater (via contact with saturated subsurface soil) are incomplete pathways because recreational users are not expected to engage in intrusive activities, and no future construction is planned. Volatilization-related inhalation exposures are also incomplete as no volatile organic compounds (VOCs) have been identified associated with munitions releases.

7.3.3.5 The AOI is expected to remain undisturbed habitat and no ongoing maintenance activities occur or are planned in the future. It is assumed that workers authorized by the Trust or law enforcement may have occasion to access the area for the purposes of inspection or security. These workers may have transient contact with surface soils but are not likely to contact the shoreline or mudflats and be exposed to surface water or sediment.

Direct Contact with Sediment and Surface Water

7.3.3.6 Clammers, scallopers, recreational and commercial fisherman, and swimmers/boaters may all contact surface water and surficial sediment (USACE 2009b). Clammers and scallopers, that dig or dredge sediments during harvesting, in particular may experience higher intensity exposure to sediments than would transient users. Pathways of exposure are incidental ingestion of and dermal contact with both water and sediment. No inhalation pathways are complete because wet sediments do not generate dust and there are no VOCs. Sediment ingestion would be limited to areas where sediment is exposed or covered by shallow water; contact with sediment in non-mudflat areas where there is deeper water is not expected. Site workers may come into contact with the shoreline or mudflats.

Ingestion of Fish and Shellfish

7.3.3.7 Local residents, and recreational users are assumed to eat clams, scallops, or fish harvested from the Cape Poge area. Fish and shellfish can accumulate contaminants from sediment or surface water.

Use of Groundwater

7.3.3.8 As indicated above, there is currently no indication that groundwater hydraulically connected to the target area is used as a water supply. However, the potential cannot be ruled out as the area is not designated as non-potable. Exposures to contaminants in groundwater when in use as a potable supply are ingestion and dermal contact. Inhalation is not a pathway of concern due to the absence of VOCs.

7.3.4 Data Screening

7.3.4.1 Because the AOI is close to a residential area, the most stringent screening levels for soil are assumed applicable. These have been identified as the lower of the USEPA Residential RSLs[1] or MADEP Method I S-1 Standard

7.3.4.2 The Method 1 Standards are not actually screening levels, but are promulgated health-based standards in Massachusetts, although they are not necessarily cleanup standards for soil (demonstrated acceptable risk in conjunction with Activity and Use Limitations often

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[1] http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm

support higher cleanup levels). However, the excess lifetime cancer risk-based target of one in a million (10^{-6}) used in the Method 1 standard derivation (along with consideration of background) is equivalent to the target cancer risk used in the RSLs. The target hazard of 0.2 is actually more stringent that the target of 1 used in the RSLs. In addition, per the Massachusetts Contingency Plan (MCP) [301 Code of Massachusetts Regulations (CMR) 40], an average concentration equivalent to the S-1 standard must be met to achieve site closure in the absence of an Activity and Use Limitation that formally limits future site use. Since such a deed instrument is not envisioned for this AOI, the S-1 standard is applicable. Method 1 GW-1 standards must also be met for all areas not designated as non-potable, regardless of current or reasonably foreseeable groundwater use, and cannot be modified by an Activity and Use Limitation. Therefore, the Method 1 S-1/GW-1 and GW-1 standards are considered appropriate for use in screening the Cape Poge data. The S-1/GW-1 soil standards are intended to be protective of direct contact as well as leaching to potable use groundwater.

7.3.4.3 Sediments are not actually soil and present a lower contact potential than soils. However, the soil values are typically used in risk screening process in the absence of published sediment screening levels for the protection of human health. Because the surficial materials at the site are accessible (unpaved) and could in theory be contacted by children at a high intensity (even if at low frequency), a Method 1 soil standard less stringent than S-1 was not considered.

7.3.4.4 Parameters above background that exceed screening levels in respective media are retained as COPCs for the HHRA. Tables 7-2, 7-3, and 7-4 present the screening results for metals in surface soil, sediment, and groundwater, respectively. As described in Section 5.3, no explosive constituents were detected in any AOI media. All reporting limits were well below screening levels and; therefore, these constituents are not reported in the risk assessment screening tables.

7.3.4.5 Five metals (antimony, copper, lead, nickel and zinc) were detected in each of the incremental and most of the discrete surface soil samples (antimony was detected in only one discrete sample; Table 7-2). Maximum concentrations, all observed at CP-11 were well below screening levels. Thus, no COPCs are identified in soil.

7.3.4.6 A similar pattern was observed for surficial sediment (Table 7-3); maximum concentrations were all below screening levels. Thus, no COPCs are identified in sediment.

7.3.4.7 In the two well samples, nickel and zinc were detected, but at concentrations well below health-based levels (Table 7-4). The reporting limit for antimony was at the screening level but not above it. Thus, no COPCs are identified in groundwater.

7.3.4.8 Because no COPCs have been identified in media at the AOI, no further risk evaluation is required. There is no unacceptable risk to human health. Under the MCP, a conclusion of No Significant Risk to Human Health has been demonstrated.

Table 7-2 Summary of Metals Screening for Soils
Former Cape Poge Little Neck Bomb Target Area of Investigation

Analyte	CAS #	Massachusetts Soil Background[1] (mg/kg)		Human Health Screening Level[2] (mg/kg)	n	FOD	RL Range (mg/kg)		Range of Detections (mg/kg)[3]		Location of Maximum Detection
		90th percentile	50th percentile				Min	Max	Min	Max[4]	
Surface Soil (0-2 inches) - Incremental Samples[5]											
Antimony	7440-36-0	NA	NA	20	9	100%	NA	NA	0.016 J	0.056 J	CP01
Copper	7440-50-8	NA	NA	3,100	9	100%	NA	NA	2.0	3.2	CP02
Lead	7439-92-1	NA	NA	300	9	100%	NA	NA	8.7	20	CP01
Nickel	7440-02-0	NA	NA	20	9	100%	NA	NA	1.4	1.7	CP02
Zinc	7440-66-6	NA	NA	2500	9	100%	NA	NA	9.2	11	CP01
Surface Soil (2-12 inches) - Discrete Samples											
Antimony	7440-36-0	1	0.34	20	24	17%	NA	NA	0.018	0.39	CP11
Copper	7440-50-8	40	7.3	3100	24	96%	NA	NA	0.68 J	2.1 J	CP11
Lead	7439-92-1	100	19.1	300	24	100%	NA	NA	3.7	82	CP11
Nickel	7440-02-0	20	5.1	20	24	100%	NA	NA	0.64	2.5	CP11
Zinc	7440-66-6	100	27.7	2500	24	100%	NA	NA	3.9	19	CP11

Notes:

[1] Background for natural soils as established by Massachusetts Department of Environmental Protection (2002)

[2] Lower of Residential Regional Screening Level; U.S. Environmental Protection Agency, 2012) and Massachusetts Department of Environmental Protection S-1/GW-1 Soil Standard (310 CMR 40.0975(6)(a)).

[3] Average of three Incremental Sampling Methodology samples; "J" values indicate all results were flagged as "J."

[4] Shaded cells indicate the value exceeds the 50th percentile of background. Values in **BOLD** exceed the screening level.

[5] Incremental sample concentrations are compared to risk screening levels only as comparison to percentile background concentrations is statistically inappropriate

Acronyms and Abbreviations:

FOD - frequency of detection

J - estimated value

mg/kg – milligrams per kilogram

n - number of samples

NA- not applicable

RL - reporting limit

% - percent

Table 7-3. Summary of Metals Screening for Sediments
Former Cape Poge Little Neck Bomb Target Area of Investigation

					RL Range (mg/kg)		Range of Detections (mg/kg)		Maximum Detection	
Analyte	**CAS #**	**Human Health Screening Level[1] (mg/kg)**	**n**	**FOD**	**Min**	**Max**	**Min**	**Max**	**Location**	**Description**
Antimony	7440-36-0	20	15	13%	0.20	0.26	0.017 J	0.020 J	CP32	South/central portion of Shear Pen Pond
Copper	7440-50-8	3,100	15	100%	NA	NA	0.34 J	5.4	CP44	Surface water body between Little Neck and Atlantic Ocean
Lead	7439-92-1	300	15	100%	NA	NA	0.80	6.3	CP32	South/central portion of Shear Pen Pond
Nickel	7440-02-0	20	15	100%	NA	NA	0.41 J	4.8 J	CP32	South/central portion of Shear Pen Pond
Zinc	7440-66-6	2500	15	100%	NA	NA	2.1 J	17	CP32	South/central portion of Shear Pen Pond

Notes:

[1] Lower of Residential Regional Screening Level (RSL; U.S. Environmental Protection Agency, 2012) and Massachusetts Department of Environmental Protection S-1/GW-1 Soil Standard (310 CMR 40.0975(6)(a)).

Acronyms and Abbreviations:

FOD - frequency of detection

J - estimated value

mg/kg – milligrams per kilogram

n - number of samples

NA - not applicable

RL - reporting limit

% - percent

Table 7-4. Summary of Metals Screening for Groundwater
Former Cape Poge Little Neck Bomb Target Area of Investigation

Analyte	CAS #	Human Health Screening Level[1] (µg/L)	n	FOD	RL Range (µg/L)		Range of Detections (µg/L)		Maximum Detection	
					Min	Max	Min	Max	Location	Description
Antimony	7440-36-0	6	2	0%	6.0	6.0	NA	NA		
Copper	7440-50-8	620	2	0%	2.0	2.0	NA	NA		
Lead	7439-92-1	15	2	0%	3.0	3.0	NA	NA		
Nickel	7440-02-0	100	2	100%	NA	NA	1.6 J	4.5	CP29	Northeastern portion of Cape Poge
Zinc	7440-66-6	4,700	2	100%	NA	NA	3.0 J	5.0 J	CP29	Northeastern portion of Cape Poge

Notes:

[1] Lower of Residential Regional Screening Level (RSL; U.S. Environmental Protection Agency, 2012) and Massachusetts Department of Environmental Protection GW-1 Groundwater Standard (310 CMR 40.0975(6)(a)).

Acronyms and Abbreviations:

FOD - frequency of detection
J - estimated value

n - number of samples
NA - not applicable
RL - reporting limit
% - percent

7.4 MC Environmental Evaluation

7.4.0.1 The purpose of this SLERA is to determine whether potentially unacceptable risks are posed to ecological receptors due to exposures to residual MCs at the AOI and to identify the specific chemicals contributing to that risk. As per the *Final United States Army Military Munitions Response Program RI/FS Guidance* (USACE, 2009c), ERAs for MMRP sites are to be performed based on USEPA guidance for conducting ERAs at CERCLA-regulated sites, principally *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments, Interim Draft* (USEPA, 1997, as implemented by USEPA, 1999). Because this site is located within the State of Massachusetts, the approach used in evaluating potential ecological risk is also consistent with a Method 3 Risk Characterization as specified by the MADEP (MADEP, 1996) under the MCP.

7.4.0.2 The ERA process under CERCLA is separable into two general phases: the SLERA and the Baseline ERA (BERA). The purpose of the SLERA is to (1) evaluate the conditions of the site to determine whether complete exposure pathways may exist between constituents of potential concern and ecological receptors, (2) identify specific ecological receptors or resources of concern and the media through which they may be exposed to site constituents, and (3) conservatively evaluate the existing data for these media to determine whether any of these constituents occur at levels that could pose an unacceptable risk to ecological receptors or resources. Constituents found to be at such levels are identified as chemicals of potential ecological concern (COPECs) for the site and a scientific/management decision is made as to whether or not these constituents warrant further investigation under the BERA), or whether a risk management or remedial action should be implemented in lieu of the BERA.

7.4.0.3 Site constituents found in the SLERA to pose a negligible potential for ecological risk, either by lack of a complete exposure pathway or by lack of a sufficient concentration in ecologically-relevant media to pose a potential risk, are eliminated from further consideration in the ERA process. If all site constituents are found in the SLERA to pose no significant risk, the ERA process is concluded with a finding of no risk and no further action based on ecological risk is required.

7.4.0.4 Because SLERAs are designed to be highly conservative in nature, they are likely to overestimate the level of risk for some receptors. For this reason, the highly conservative initial screening of the data (as per USEPA guidance) is followed by a more realistic (i.e., less conservative) refinement of the evaluation of potential risk for constituents that do not pass the initial risk screening. The purpose of this step is to reduce the possibility that one or more COPECs are carried into the BERA when sufficient information currently exists to support a conclusion that they do not pose significant risk.

7.4.0.5 The MADEP process is similar: in a Stage I screening characterization, the potential for complete exposure pathways is evaluated. Contamination concentrations present in potentially affected media associated with complete pathways are then compared to published effects-based benchmarks. If concentrations exceed benchmarks, the process proceeds to a Stage II environmental risk characterization, which can vary in scope but generally follows the USEPA guidance for more complex assessments. If concentrations do not exceed screening levels, no further evaluation is required and a condition of "No Significant Risk to the Environment" is concluded. The only key differences between the Federal and Massachusetts processes is that the MCP allows consideration of background in elimination of media from further concern, and that the Stage I process considers benchmarks only and does not evaluate dose as the SLERA may.

7.4.0.6 Finally, due to the historical use of this site as a target for practice aerial bombing, the constituents of potential concern for this evaluation are limited to MCs, including selected metals (antimony, copper, lead, nickel, and zinc) and explosives (and their by-products). This assessment assumes that all of these constituents have potentially toxic characteristics to ecological receptors if certain threshold levels in the environment are exceeded [see the RI Work Plan (UXB, 2011) Worksheet #15 for ecological screening levels for these constituents]. Three classes of environmental media at the AOI (soil, sediment, and groundwater) were sampled in 2011 and analyzed for these constituents. Results of sample analyses form the basis of this SLERA.

7.4.0.7 The presentation of this SLERA is structured in accordance with the three-step paradigm for ERAs (USEPA, 1998). These are:

1. Preliminary Problem Formulation;
2. Analysis; and,
3. Risk Characterization.

7.4.1 Preliminary Problem Formulation

7.4.1.0.1 In the Preliminary Problem Formulation, the potentially affected environment is described and a CSM is developed to identify fate and transport mechanisms that could lead to potentially complete exposure pathways to ecological receptors. Key ecological resources are identified and assessment and measurement endpoints are developed for the protection of those resources. The elements of the Problem Formulation for the AOI are described in the following sections.

7.4.1.1 Site Description and Ecological Resources

7.4.1.1.1 The AOI is located on Chappaquiddick Island, within the Town of Edgartown, Martha’s Vineyard, Massachusetts. The Little Neck Bomb Target Range was used during World War II as a practice bombing range. Military practice ordnance used at the Little Neck Bomb Target range included the AN-MK5 and AN-MK23 practice bombs. Practice bombs and bomb fragments have been observed on the property.

7.4.1.1.2 The current AOI encompasses an area of approximately 800 acres and includes four habitat types: 1) upland habitat (153 acres); 2) inland water (500 acres); 3) beach (83 acres); and 4) ocean (64 acres) (see Figure 2-2). Part of the AOI is within the Cape Poge Wildlife Refuge, which is owned and operated by TTOR and is open to the public for recreational use. Other landowners include private landowners and the Commonwealth of Massachusetts (inland and coastal waters).

7.4.1.1.3 As described in the RI work plan (UXB, 2011), the AOI contains significant ecological resources and is potential habitat for threatened, endangered, or other sensitive or protected species. These include the following four species of seabirds/shorebirds that could use the beach, ocean, or inland water habitats:

- Common tern (*Sterna hirundo*)—State Species of Special Concern;
- Least tern (*Sterna antillarum*)—State Species of Special Concern;
- Roseate tern (*Sterna dougallii dougallii*)—State/Federal Endangered Species; and,
- Piping plover (*Charadrius melodus*)—State/Federal Threatened Species.

7.4.1.1.4 The ocean habitat of the site could potentially be used by protected sea turtles, including:

- Green sea turtle (*Chelonia mydas*)—State/Federal Threatened Species;
- Kemp's Ridley sea turtle (*Lepidochelys kempi*)—State/Federal Endangered Species;
- Leatherback sea turtle (*Dermochelys coriacea*)—State/Federal Endangered Species; and,
- Loggerhead sea turtle (*Caretta caretta*)—State/Federal Threatened Species.

7.4.1.1.5 The beach area is potential habitat for the sea-beach knotweed (*Polygonum glaucum*), a State Species of Special Concern, and the upland area is potential habitat for the northern harrier (*Circus cyaneus*), a State Threatened Species.

7.4.1.1.6 In addition, most of the inland water habitat of this AOI is classified as a Priority Natural Vegetation Community for seagrass (specifically eelgrass) and as Shellfish Suitability Areas for bay scallop, quahog, and soft-shell clams.

7.4.1.1.7 On 17 March 2011, a botanist conducted a sensitive plant survey of the upland target area of Little Neck prior to its sampling (AMEC, 2011). The lowest, intertidal estuarine areas were found to be dominated by salt-meadow cordgrass (*Spartina patens*), salt-marsh cordgrass (*S. alterniflora*), salt grass (*Distichlis spicata*), and glasswort (*Salicornia* sp.). Above these areas was an estuarine, broad-leaved deciduous scrub/shrub vegetation dominated by groundsel-bush (*Baccharis halimifolia*), which was found in dense thickets throughout Little Neck. Also present in the vegetation were northern bayberry (*Myrica pennsylvanica*), poison sumac (*Toxicodendron vernix*), Virginia rose (*Rosa virginiana*), grape (*Vitis* sp.), and Oriental bittersweet (*Celastrus orbiculata*). Big-leaf sumpweed (*Iva frutescens*) formed a fringe around these estuarine wetlands. Above these areas (in the driest parts of Little Neck upland habitat), eastern red cedar (*Juniperus virginiana*) was the most common species, with a few individuals of scrub oak (*Quercus ilicifolia*) along with Virginia creeper (*Parthenocissus quinquefolia*) common yarrow (*Achillea millefolium*), and switch grass (*Panicum virgatum*).

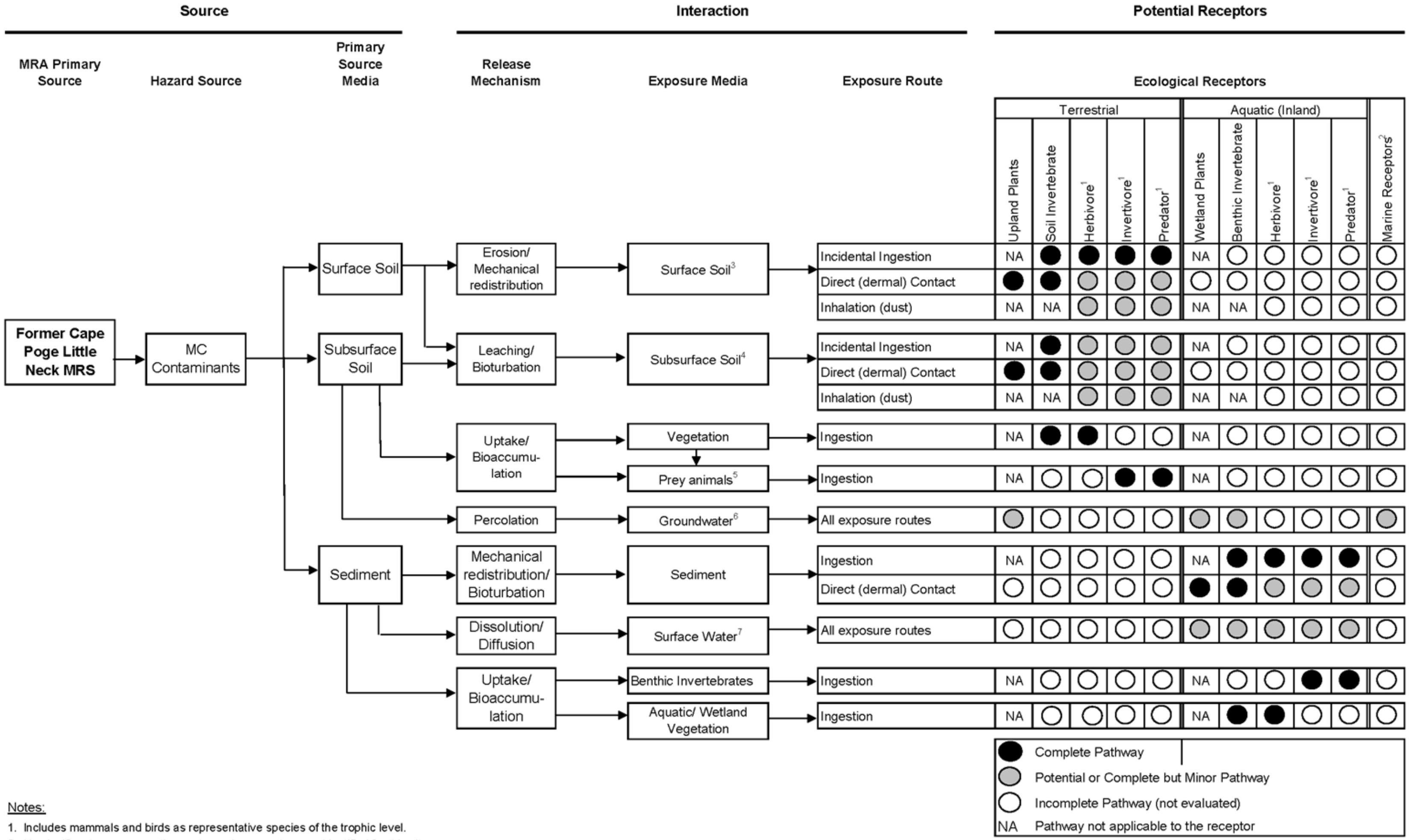
7.4.1.2 Conceptual Site Model

7.4.1.2.1 A detailed CSM for ecological exposures at the AOI is presented on Figure 7-2. The media of primary ecological concern at this site are surface and near surface soil (upland habitat) and sediment (inland water habitat). For plants and soil/benthic invertebrates within these habitats, primary exposures to MCs are through direct contact with the soil or sediment. For wildlife receptors, the primary complete exposure pathways are the incidental ingestion of contaminated soil/sediment and transfers through the food web.

7.4.1.3 Data Summary and Initial Screening

7.4.1.3.1 The MC sampling strategy for the AOI was based on the results of geophysical surveys and subsequent intrusive investigations of the site. Three areas in the upland habitat with high anomaly densities were identified for soil sampling (Figure 5-1). At each of these areas, 3 incremental samples of the top 2 in. were collected followed by 8 discrete, biased, surface samples (2 to 12 in.) and 8 discrete subsurface samples (12 to 18 in.). Fifteen sediment samples were collected to determine if MCs are present within Cape Poge Bay, Shear Pen Pond, and Drunkard's Cove (known clamming area) (Figure 4-2). Ten sediment samples (0 to 6 in.) were collected from the inland water area of Cape Poge Bay west of the target area. One sediment sample (0 to 6 in.) was collected from Shear Pen Pond northeast of the target and 4 from Drunkard's Cove (1 from 0 to 6 in. and 3 [associated with the scalloping area] from 0 to 12 in.). Groundwater samples were also collected from this AOI; however, groundwater was not considered to be an ecologically-relevant medium.

Figure 7-2. Ecological Conceptual Site Model for the Former Cape Poge Little Neck Bomb Target Area of Interest



		Terrestrial					Aquatic (Inland)					
Exposure Media	Exposure Route	Upland Plants	Soil Invertebrate	Herbivore[1]	Invertivore[1]	Predator[1]	Wetland Plants	Benthic Invertebrate	Herbivore[1]	Invertivore[1]	Predator[1]	Marine Receptors[2]
Surface Soil[3]	Incidental Ingestion	NA	●	●	●	●	NA	○	○	○	○	○
	Direct (dermal) Contact	●	●	◍	◍	◍	○	○	○	○	○	○
	Inhalation (dust)	NA	NA	◍	◍	◍	NA	NA	○	○	○	○
Subsurface Soil[4]	Incidental Ingestion	NA	●	◍	◍	◍	NA	○	○	○	○	○
	Direct (dermal) Contact	●	●	◍	◍	◍	○	○	○	○	○	○
	Inhalation (dust)	NA	NA	◍	◍	◍	NA	NA	○	○	○	○
Vegetation	Ingestion	NA	●	●	○	○	NA	○	○	○	○	○
Prey animals[5]	Ingestion	NA	○	○	●	●	NA	○	○	○	○	○
Groundwater[6]	All exposure routes	◍	○	○	○	○	◍	◍	○	○	○	◍
Sediment	Ingestion	NA	○	○	○	○	NA	●	●	●	●	○
	Direct (dermal) Contact	○	○	○	○	○	●	●	◍	◍	◍	○
Surface Water[7]	All exposure routes	○	○	○	○	○	◍	◍	◍	◍	◍	○
Benthic Invertebrates	Ingestion	NA	○	○	○	○	NA	○	○	●	●	○
Aquatic/ Wetland Vegetation	Ingestion	NA	○	○	○	○	NA	●	●	○	○	○

● Complete Pathway
◍ Potential or Complete but Minor Pathway
○ Incomplete Pathway (not evaluated)
NA Pathway not applicable to the receptor

Notes:

1. Includes mammals and birds as representative species of the trophic level.
2. No significant exposure pathways to marine receptors are identified for this site.
3. Surface soil represented by soil samples collected from 0 - 2 inches and 2 - 12 inches below ground surface (bgs).
4. Subsurface soil represented by soil samples collected between 12 and 18 inches bgs.
5. Prey animals include soil invertebrates for the invertivores and herbivorous mammals for the predators.
6. Significant migration of MC to groundwater at this site is not anticipated.
7. Significant release of MC to surface water at this site is not anticipated.

7.4.1.3.2 Soil and sediment samples were analyzed for metals (USEPA Method 6020A) and high explosives and their by-products (USEPA Method 8321B). Metals analyses were limited to five analytes: antimony, copper, lead, nickel, and zinc. Results of sample analyses are summarized in Tables 7-5 (soil) and 7-6 (sediment). Results of explosives analyses (both soil and sediment) are summarized in Table 7-7. In these summaries, data from duplicate discrete samples (collected for QA purposes) were combined as a single point based on the following rules:

- If both values were detects, the arithmetic mean of the two was used;
- If both values were non-detects, the lower of the two ½ reporting limit values was used; and,
- If one value was detected and the other was a non-detect, the final result was calculated as the arithmetic mean of the detected value and ½ the reporting limit of the nondetect. If ½ the reporting limit value was greater than the detect, however, only the detected concentration was used.

7.4.1.3.3 Note that the three IS samples were treated as distinct samples, not as replicates. These data were screened for preliminary COPECs based on the following criteria:

- The analyte was detected in more than 5 percent of the samples for each medium sampled (if fewer than 20 data points are available for the constituent, then at least one must be a detection);
- The maximum analyte concentration exceeds an identified background screening level for that medium; and,
- The maximum analyte concentration exceeds the corresponding ecologically-based screening criterion.

7.4.1.3.4 Analytes that do not meet any of the above criteria were eliminated from further consideration as COPECs for the medium in question. The resulting list of preliminary COPECs was further evaluated for potential ecological risk in the SLERA.

7.4.1.3.5 In soil, all five metal analytes (antimony, copper, lead, nickel, and zinc) were detected in at least three samples in each depth interval (Table 7-5). As an initial screening of these data, the maximum detected concentrations were compared against MADEP accepted state-wide background concentrations for natural soils (MADEP, 2002a). In no case did the maximum detected concentration of a metal exceed the MADEP accepted background concentration as based on the 90th percentile of natural background values. However, this does not immediately exclude these analytes as being potential COPECs. Examination of their spatial distribution indicates a potential anthropogenic release at the site possibly related to the past use as a target. In particular, it is noted that the maximum concentrations of all five metals in the 2 to 12 in. depth interval were from a single sample (CP11) with the concentration of lead in that

Table 7-5. Summary of Metals Analysis Results for Soils of the Upland Habitats
Former Cape Poge Little Neck Bomb Target Area of Investigation

		Massachusetts Soil Background[1] (mg/kg)		USEPA EcoSSL[2] (mg/kg)			RL Range (mg/kg)		Range of Detections (mg/kg)		Location of Maximum Detection
Analyte	CAS #	90th %'tile	50th %'tile		n	FOD	Min	Max	Min	Max[3]	
Surface Soil (0-2 inches) - Incremental Sampling											
Antimony	7440-36-0	1	0.34	0.27	9	100%	NA	NA	0.014 J	0.083 J	CP01 (IS02)
Copper	7440-50-8	40	7.3	28	9	100%	NA	NA	1.8 J	3.6 J	CP02 (IS06)
Lead	7439-92-1	100	19.1	11	9	100%	NA	NA	8.0 J	**25.0 J**	CP01 (IS02)
Nickel	7440-02-0	20	5.1	38	9	100%	NA	NA	1.3 J	2.0 J	CP02 (IS06)
Zinc	7440-66-6	100	27.7	46	9	100%	NA	NA	8.8 J	13.0 J	CP01 (IS02)
Surface Soil (2-12 inches) - Discrete Samples											
Antimony	7440-36-0	1	0.34	0.27	24	16.7%	0.19	0.24	0.018 J	**0.39**	CP11
Copper	7440-50-8	40	7.3	28	24	95.8%	0.68	0.68	0.68 J	2.1	CP11
Lead	7439-92-1	100	19.1	11	24	100%	NA	NA	3.7	**82**	CP11
Nickel	7440-02-0	20	5.1	38	24	100%	NA	NA	0.64	2.5	CP11
Zinc	7440-66-6	100	27.7	46	24	100%	NA	NA	4	19	CP11
Subsurface Soil (12-18 inches) - Discrete Samples											
Antimony	7440-36-0	1	0.34	0.27	24	12.5%	0.18	0.23	0.016 J	0.072 J	CP11
Copper	7440-50-8	40	7.3	28	24	100%	NA	NA	0.66 J	1.7 J	CP12
Lead	7439-92-1	100	19.1	11	24	100%	NA	NA	2.4	**17**	CP11
Nickel	7440-02-0	20	5.1	38	24	100%	NA	NA	0.94	4.4	CP12&CP16
Zinc	7440-66-6	100	27.7	46	24	100%	NA	NA	4.4	11	CP11

Notes:

[1] Background for natural soils as established by Massachusetts Department of Environmental Protection (2002)

[2] from U.S. Environmental Protection Agency (USEPA) (2005a, b; 2007a, b, c)

[3] Shaded cells indicate the value exceeds the 50th percentile of background. Values in **BOLD** exceed the USEPA Ecological Soil Screening Levels.

Acronyms and Abbreviations:

FOD - frequency of detection	**RL** - reporting limit
J - estimated value	**%** - percent
n - number of samples	**%'tile** - percentile
NA - not applicable	**mg/kg** – milligrams per kilogram

Table 7-6. Summary of Metals Analysis Results for Sediments of the Inland Water Habitats Former Cape Poge Little Neck Bomb Target Area of Investigation

Analyte	CAS #	ESL[1] (mg/kg)	n	FOD	RL Range (mg/kg)		Range of Detections (mg/kg)		Location of Maximum Detection
					Min	Max	Min	Max	
Antimony	7440-36-0	2	15	13.3%	0.20	0.26	0.017 J	0.020 J	CP32
Copper	7440-50-8	16	15	100%	NA	NA	0.34 J	5.4	CP44
Lead	7439-92-1	30.2	15	100%	NA	NA	0.80	6.3	CP32
Nickel	7440-02-0	15.9	15	100%	NA	NA	0.41 J	4.8 J	CP32
Zinc	7440-66-6	121	15	100%	NA	NA	2.1 J	17	CP32

Notes:

[1] Ecological screening levels (ESLs) for freshwater sediments from U.S. Environmental Protection Agency Region 4 (2001), Region 5 (2003), and Region 6 (1999)

Acronyms and Abbreviations:

FOD - frequency of detection
J - estimated value
mg/kg – milligrams per kilogram
n - number of samples
NA - not applicable
RL - reporting limit
% - percent

Table 7-7. Summary of Explosives Analysis Results for Soils and Sediments
Former Cape Poge Little Neck Bomb Target, Martha's Vineyard, Massachusetts

			Surface Soil-IS (0-2 inches)				Surface Soil (2-12 inches)				Subsurface Soil (12-18 inches)				Sediment (0-12 inches)				
Analyte	CAS #	ESL (soil)[1] (mg/kg)	n	FOD	RL-min (mg/kg)	RL-max (mg/kg)	n	FOD	RL-min (mg/kg)	RL-max (mg/kg)	n	FOD	RL-min (mg/kg)	RL-max (mg/kg)	ESL (sediment)[1] (mg/kg)	n	FOD	RL-min (mg/kg)	RL-max (mg/kg)
1,3,5-Trinitrobenzene	99-35-4	0.376	9	0%	0.091	0.10	24	0%	0.091	0.099	24	0%	0.091	0.099	0.24	15	0%	0.091	0.099
1,3-Dinitrobenzene	99-65-0	0.073	9	0%	0.091	0.10	24	0%	0.091	0.099	24	0%	0.091	0.099	0.67	15	0%	0.091	0.099
Nitrobenzene	98-95-3	1.31	9	0%	0.091	0.10	24	0%	0.091	0.099	24	0%	0.091	0.099	0.145	15	0%	0.091	0.099
2,4,6-Trinitrotoluene	118-96-7	6.4	9	0%	0.091	0.10	24	0%	0.091	0.099	24	0%	0.091	0.099	9.2	15	0%	0.091	0.099
2-Amino-4,6-dinitrotoluene	35572-78-2	10	9	0%	0.091	0.10	24	0%	0.091	0.099	24	0%	0.091	0.099	34	15	0%	0.091	0.099
4-Amino-2,6-dinitrotoluene	19406-51-0	3.6	9	0%	0.091	0.10	24	0%	0.091	0.099	24	0%	0.091	0.099	9.5	15	0%	0.091	0.099
2,4-Dinitrotoluene	121-14-2	1.28	9	0%	0.091	0.10	24	0%	0.091	0.099	24	0%	0.091	0.099	0.0144	15	0%	0.091	0.099
2,6-Dinitrotoluene	606-20-2	0.0328	9	0%	0.091	0.10	24	0%	0.091	0.099	24	0%	0.091	0.099	0.0398	15	0%	0.091	0.099
2-Nitrotoluene	88-72-2	9.9	9	0%	0.091	0.10	24	0%	0.091	0.099	24	0%	0.091	0.099	28	15	0%	0.091	0.099
3-Nitrotoluene	99-08-1	12	9	0%	0.091	0.10	24	0%	0.091	0.099	24	0%	0.091	0.099	24	15	0%	0.091	0.099
4-Nitrotoluene	99-99-0	22	9	0%	0.091	0.10	24	0%	0.091	0.099	24	0%	0.091	0.099	52	15	0%	0.091	0.099
Nitroglycerin	55-63-0	71	9	0%	0.091	0.10	24	0%	0.091	0.099	24	0%	0.091	0.099	1,700	15	0%	0.091	0.099
HMX	2691-41-0	27	9	0%	0.091	0.10	24	0%	0.091	0.099	24	0%	0.091	0.099	0.47	15	0%	0.091	0.099
PETN	78-11-5	100	9	0%	0.091	0.10	24	0%	0.091	0.099	24	0%	0.091	0.099	1,400	15	0%	0.091	0.099
RDX	121-82-4	7.5	9	0%	0.091	0.10	24	0%	0.091	0.099	24	0%	0.091	0.099	1.3	15	0%	0.091	0.099
Tetryl	479-45-8	0.99	9	0%	0.091	0.10	24	0%	0.091	0.099	24	0%	0.091	0.099	100	15	0%	0.091	0.099

Notes:

[1] Ecological screening levels (ESLs) for soil and sediments from Los Alamos National Laboratory (2011), Talmage et al. (1999), and U.S. Environmental Protection Agency Region 5 (2003). Shaded cells indicate ESL < Min RL.

Acronyms and Abbreviations:

FOD - frequency of detection
IS - Incremental Sampling
mg/kg - milligrams per kilogram
n - number of samples
RL-min - minimum reporting limit
RL-max - maximum reporting limit

sample (82 mg/kg) being significantly higher than that of all other discrete soil samples. Further, the incremental sample-based concentrations of antimony and lead were generally higher at sampling area CP01 (which contained discrete sampling location CP11) than at either of the other two incremental sampling areas.

7.4.1.3.6 To evaluate the potential for metals to be within a reasonable range of natural background concentration, the maximum concentrations were compared to the 50th percentile of natural background levels for the State, which is a more stringent criterion for background levels (MADEP, 2002a). As seen in Table 7-5, copper, nickel, and zinc concentrations were all below the 50th percentile of natural background, and were therefore considered to be within background ranges. The maximum detections of both antimony [0.39 milligrams per kilogram (mg/kg)] and lead (82 mg/kg) exceeded their respective 50th percentiles of background (0.34 mg/kg and 19.1 mg/kg), albeit in the case of antimony, only slightly so. Locations where antimony and lead exceeded 50th percentiles of background were limited to the surface soil (2 to 12 in.) for antimony and both surface soil and near surface soil (0 to 2 in. and 2 to 12 in.) for lead.

7.4.1.3.7 The maximum concentrations of these metals were then compared to USEPA Ecological Soil Screening Levels (EcoSSLs) (USEPA, 2005a,b; 2007a,b,c). As shown in Table 7-5, the maximum detected concentrations of copper, nickel, and zinc were less than their corresponding EcoSSLs; however, those of antimony and lead exceeded their EcoSSLs (for lead, all three depth intervals exceeded the EcoSSLs). Therefore, due to the possibility that the levels of both antimony and lead in the soil have been influenced by anthropogenic releases and both could be at levels that pose a potential risk to ecological receptors, both were retained as preliminary COPECs for further risk characterization in the SLERA.

7.4.1.3.8 In sediments, each of the five metal analytes (antimony, copper, lead, nickel, and zinc) were detected in at least two sediment samples (Table 7-6). Although background screening levels are not available for this medium, in all cases, the maximum detected concentration [and, in the case of antimony, the maximum reporting limit (RL)] was less than the corresponding ecological screening level for sediment. Therefore, no metals are identified as COPECs for sediment. Note that although all of the ecological sediment screening levels for metals listed in Table 7-6 are from USEPA Regional guidance (the minimum value from USEPA Region 4 [2001], Region 5 [2003], and Region 6 [1999]), all of these values are less than or equal to the corresponding MADEP freshwater sediment quality guidelines (MADEP, 2002b).

7.4.1.3.9 The results from the explosives analyses (Table 7-7) indicate that none of the explosives compounds are present at detectable concentrations in both soil (all intervals) and sediment. With only a few exceptions in each of these media, the reporting limits for these analyses are less than the ecological screening levels. Because the screening levels in those exceptional cases are relatively close to the reporting limits and reporting limits exceed that actual limit of detection, it can be concluded that these exceptions do not represent a significant potential for ecological risk from undetected levels of explosives residues in soil or sediment. Therefore, none of the 16 explosive compounds or their breakdown products are considered a COPEC and are eliminated from further evaluation in this assessment.

7.4.1.3.10 Based on this initial screening of MCs in soil and sediment, antimony (surface soil) and lead (surface soil and near surface soil) are identified as preliminary COPECs in soil. No COPECs are identified for sediment.

7.4.1.4 Assessment and Measurement Endpoints

7.4.1.4.1 Assessment endpoints represent an explicit expression of actual environmental values to be protected at a site. Measurement endpoints represent quantifiable ecological characteristics that can be measured, interpreted, and related to valued ecological component(s) chosen as the assessment endpoints. Preliminary assessment and measurement endpoints for this SLERA are presented in Table 7-8. Because preliminary COPECs were limited to upland habitat, all assessment and measurement endpoints are directed toward this habitat. For each measurement endpoint shown in Table 7-8, the key ecological receptor(s) associated with that endpoint is identified. These receptors reflect those used by USEPA to derive the EcoSSLs for the specific COPECs (i.e., plants; soil invertebrates; herbivorous, insectivorous, and carnivorous birds; and herbivorous, insectivorous, and carnivorous mammals).

7.4.2 Analysis

7.4.2.0.1 The Analysis phase of the SLERA involves two steps: estimation of potential exposures (Exposure Assessment) and identification of thresholds of effects, such as toxicologically based benchmarks or established ecological screening values (Effects Evaluation), which are described in the following sections.

**Table 7-8. Assessment and Measurement Endpoints, SLERA
Former Cape Poge Little Neck Bomb Target Area of Investigation**

Habitat Type	Assessment Endpoint	Measurement Endpoint	Key Ecological Receptor
Upland (terrestrial)	Protection of terrestrial plant populations from exposures to MC residues that could adversely affect growth, reproduction, or survival.	Comparison of soil exposure point concentration (EPC) to established plant toxicity benchmark.	Terrestrial plants (generic)
Upland (terrestrial)	Protection of soil invertebrate populations from exposures to MC residues that could adversely affect growth, reproduction, or survival.	Comparison of soil EPC to established soil invertebrate toxicity benchmark.	Earthworms
	Protection of herbivorous wildlife populations from exposures to MC residues that could adversely affect growth, reproduction, or survival.	Comparison of soil EPC to established avian and mammalian toxicity benchmarks.	Dove (bird) Vole (mammal)
	Protection of insectivorous wildlife populations from exposures to MC residues that could adversely affect growth, reproduction, or survival.	Comparison of soil EPC to established avian and mammalian toxicity benchmarks.	Woodcock (bird) Shrew (mammal)
	Protection of carnivorous wildlife populations from exposures to MC residues that could adversely affect growth, reproduction, or survival.	Comparison of soil EPC to established avian and mammalian toxicity benchmarks.	Hawk (bird) Weasel (mammal)

7.4.2.1 Exposure Assessment

7.4.2.1.1 An Exposure Assessment is the process of estimating the magnitude of potential exposures of selected ecological receptors to COPECs present at the site. This includes identification of the EPC in each relevant medium that reasonably represents the expected level of exposure that would be experienced by an individual of the receptor species using the site. For initial data screening, a potential exposure level was conservatively estimated as the maximum measured concentration. However, a more realistic estimate of the EPC within the target area (at least for a typical individual) would be the mean of these samples, which can be conservatively estimated by its 95 percent upper confidence limit (UCL) of the mean. The USEPA Pro-UCL Version 4.1.01 software package (USEPA, 2011) was used to estimate the 95 percent UCLs for antimony and lead in soil (Table 7-9). These 95 percent UCL estimates were used as EPCs for risk characterizations in this SLERA. For reference purposes, the means of the data sets (as based on the use of one half the RL for non-detections) are also presented in Table 7-9.

Table 7-9. Calculation of 95 Percent UCLs for Metals in Soils of the Upland Habitats Former Cape Poge Little Neck Bomb Target Area of Investigation

Analyte	CAS #	USEPA EcoSSL[1] (mg/kg)	Approximate Distribution[2]	Arithmetic Mean[3] (mg/kg)	95% UCL of the Mean[4,5] (mg/kg)	Basis of 95% UCL[2]
Surface Soil (0-2 inches) - Incremental Sampling						
Antimony	7440-36-0	0.27	Normal	0.040	0.054	Student's t
Copper	7440-50-8	28	Normal	2.54	2.91	Student's t
Lead	7439-92-1	11	Normal	14.7	**18.3**	Student's t
Nickel	7440-02-0	38	Gamma	1.53	1.67	Approx. gamma
Zinc	7440-66-6	46	Normal	10.3	11.2	Student's t
Surface Soil (2-12 inches) - Discrete Samples						
Antimony	7440-36-0	0.27	None	0.107	0.143	97.5% KM Chebyshev
Copper	7440-50-8	28	None	1.10	1.35	95% KM Chebyshev
Lead	7439-92-1	11	None	11.3	**25.2**	95% Chebyshev
Nickel	7440-02-0	38	Normal	1.42	1.57	Student's t
Zinc	7440-66-6	46	Gamma	6.49	7.44	Approx. gamma
Subsurface Soil (12-18 inches) - Discrete Samples						
Antimony	7440-36-0	0.27	Normal	0.096	0.080	Student's t
Copper	7440-50-8	28	Normal	1.13	1.24	Student's t
Lead	7439-92-1	11	Gamma	5.56	6.68	Approx. gamma
Nickel	7440-02-0	38	Normal	2.49	2.85	Student's t
Zinc	7440-66-6	46	Normal	7.33	7.98	Student's t

Notes:
[1] from U.S. Environmental Protection Agency (2005a, b; 2007a, b, c)
[2] As per U.S. Environmental Protection Agency Pro-UCL version 4.1.01 (USEPA, 2011).
[3] Non-detections included as 1/2 the reporting limit.
[4] Based on 95 percent Upper Confidence Limit estimate recommended by U.S. Environmental Protection Agency Pro-UCL version 4.1.01 (USEPA, 2011).
[5] Values in **BOLD** exceed the U.S. Environmental Protection Agency Ecological Soil Screening Levels.

Acronyms and Abbreviations:
KM - Kaplan-Meier
mg/kg - milligrams per kilogram
% - percent
UCL - upper confidence limit
n - number of samples

7.4.2.2 Effects Evaluation

7.4.2.2.1 The Effects Evaluation establishes toxicity benchmarks against which EPCs are compared to characterize potential risk to specific receptors. The USEPA has developed conservative EcoSSLs for both antimony and lead (USEPA, 2005a and b) which were used in this. In both cases, the minimum EcoSSL of the receptor groups was used as the benchmark (Table 7-9); however, it should be noted that insufficient toxicity data exists to derive EcoSSLs for antimony exposure in birds and plants. Therefore, the EcoSSL for antimony is the minimum value (three trophic levels) and soil invertebrates.

7.4.2.2.2 For antimony, the EcoSSL (0.27 mg/kg) is based on insectivorous mammals. For lead, the EcoSSL (11 mg/kg) is based on insectivorous birds. It should be noted that the selected

EcoSSLs for both metals are several fold below USEPA and MADEP reported background concentrations.

7.4.3 Risk Characterization

7.4.3.1 Based upon the evaluation of soil and sediment data, two analytes (antimony and lead) were identified as preliminary COPECs requiring further evaluation for potential ecological risk. Risk characterization of these two metals was based on the calculation of hazard quotients of the form:

$$HQ = \frac{EPC}{EcoSSL}$$

Where:

HQ = Hazard quotient (unitless)

EPC = Exposure point concentration (mg/kg)

EcoSSL = Ecological soil screening level (mg/kg)

7.4.3.2 A HQ less than or equal to 1 indicates that the EPC is less than or equal to the EcoSSL and therefore, the conclusion can be drawn that potential for significant risk is negligible for that COPEC in that medium and the COPEC can be eliminated from further consideration. If, however, the calculated HQ is greater than 1, then a conclusion of negligible risk cannot be drawn and the COPEC is retained for further evaluation. Note that it is not concluded that the COPEC poses a risk when the HQ exceeds 1 since this could be the result of multiple conservatisms built into both the EPC and the EcoSSL. Such conservatisms are evaluated in the refined risk screening for those COPECs showing HQs greater than 1 and discussed in the uncertainty analysis.

7.4.3.3 EPCs used in the risk characterization are the 95 percent UCLs for antimony (2 to12 in.) and lead (all depth intervals) as presented in Table 7-9. The minimum EcoSSLs for these two metals as derived by the USEPA [0.27 mg/kg for antimony (USEPA, 2005a) and 11 mg/kg for lead (USEPA, 2005b)] were used to initially screen these EPCs for potential ecological risk. Results of initial screening of antimony and lead in soil at the AOI are as follows:

Antimony (2 to 12 in.): $HQ_{initial} = \frac{0.143\ mg/kg}{0.27\ mg/kg} = 0.5$

Lead (0 to 2 in.): $HQ_{initial} = \frac{18.3\ mg/kg}{11\ mg/kg} = 1.7$

Lead (2 to 12 in.): $HQ_{initial} = \frac{25.2\ mg/kg}{11\ mg/kg} = 2.3$

Lead (12 to 18 in.): $HQ_{initial} = \frac{6.68\ mg/kg}{11\ mg/kg} = 0.6$

7.4.3.4 These results indicate that antimony can be eliminated from further consideration as a COPEC and lead can be eliminated as a COPEC for near surface soil (12 to 18 in). Lead in surface soil (0 to 2 in and 2 to 12 in) is not eliminated; however, the HQs are very low.

7.4.3.1 Refined Risk Screening

7.4.3.1.1 In the refinement of initial risk screening, the HQs are recalculated based on a less conservative estimate of the threshold of adverse effects (i.e., the EcoSSL) for lead. It should be noted that the EcoSSL for lead (11 mg/kg) is based on exposure in the American woodcock (*Scolopax minor*). The next smallest EcoSSL, derived by USEPA for lead, is 56 mg/kg (for a shrew), which is greater than the 95 percent UCLs for lead in soil. Therefore, refinement of risk estimation for lead is focused on conservative assumptions used to derive the EcoSSL for the woodcock.

7.4.3.1.2 The EcoSSLs for wildlife receptors are based on the solution of the following equation under the condition that HQ=1 (USEPA, 2005b):

$$HQ = \ FIR\ \cdot (C_s \cdot P + B)/TRV$$

Where:

HQ = the hazard quotient (set at 1)

FIR = food ingestion rate of the receptor (in kg dry weight of food per kg body weight per day [kg dw/kg-day])

C_s = the soil concentration of the COPEC (in mg/kg)

P = the ingestion rate of soil as a proportion of FIR (unitless)

B = the concentration of the COPEC in the food of the receptor (i.e., earthworms) (in mg/kg dw)

TRV = the toxicity reference value for the receptor based on chronic oral exposure to the COPEC (in mg per kg body weight per day [mg/kg-day])

7.4.3.1.3 The concentration of lead in earthworm tissue (B) is estimated by the relationship (USEPA, 2005b):

$$\ln(B) = \ 0.807 \cdot \ln(C_s) - 0.218$$

Where:

B = the concentration of the COPEC in the earthworm tissues (in mg/kg dw)

C_s = the soil concentration of the COPEC (in mg/kg)

ln(X) = the natural logarithm of X

7.4.3.1.4 The EcoSSL is defined as the value of C_s that results in a HQ of 1 in the first equation. The TRV for oral lead exposure in birds was derived by USEPA (2005b) to be 1.63 mg/kg-day, which is based on no-observed-adverse-effect level for chronic exposure. This value was not changed in the refined assessment of risk.

7.4.3.1.5 It is noted that both the value for FIR and P used in the derivation of EcoSSL are based on conservative estimates of these two exposure factors. The FIR is based on maximum food ingestion rate of the American woodcock of 1.43 kg wet weight (ww) per kilogram (kg) body weight per day (kg ww/kg-day) as reported in the USEPA Wildlife Exposure Factors Handbook (USEPA, 1993). When converted to a dry weight basis [based on an assumed water content in earthworms of 85 percent (USEPA, 1993)], the FIR used in the EcoSSL is obtained (0.214 kg dw/kg-day). However, mean food ingestion rate for the woodcock as presented by USEPA (1993) is 0.77 kg ww/kg-day, or 0.116 kg dw/kg-day based on the same assumption of water content. In the case of P, 16.4 percent is used in the derivation of the EcoSSL to estimate incidental soil ingestion by the woodcock (USEPA, 1993); however, USEPA presents a lesser value of 10.4 percent for this species. Substituting these two less conservative exposure factors (i.e., FIR = 0.116 kg dw/kg-day and P = 10.4 percent) into the equations above and solving for C_s under the condition that HQ = 1, a refined Soil Screening Level of 26.4 mg/kg is obtained. This results in the following changes to the HQs for lead in the surface soil:

Lead (0 to 2 in.): $$HQ_{refined} = \frac{18.3\ mg/kg}{26.4\ mg/kg} = 0.69$$

Lead (2 to 12 in.): $$HQ_{refined} = \frac{25.2\ mg/kg}{26.4\ mg/kg} = 0.95$$

7.4.3.1.6 Thus, these two modifications in the exposure factors used to derive the EcoSSL for lead in the American woodcock are sufficient to eliminate lead as a COPEC at this site.

7.4.3.2 Uncertainty Analysis

7.4.3.2.1 Throughout the risk assessment process, there are many uncertainties stemming from imperfect knowledge and data gaps that necessitate the implementation of assumptions that allows the process to proceed. Each of these assumptions has the capacity to influence the resulting prediction of potential risk to different degrees and in different direction from the "true" level of risk posed by the site. Thus, these assumptions may lead to either an overestimation of actual site risk, thereby favoring a greater degree of caution and protection of environmental resources (often referred to as "conservatism"), or to an underestimation of actual site risk, which could ultimately lead to an inadequate response.

7.4.3.2.2 The ERA process is designed to proceed in an iterative approach from highly conservative estimates of potential risk to estimates that can be accepted as more accurate yet still conservative predictions of actual site risk. Although refinement of exposure factors used to derive the screening level for lead represents a step in the reduction of conservatism inherent in the HQs for this metal, many other assumptions, both implicit and explicit, remain unchanged. In the following sections, some areas of uncertainty and assumptions used to address them in this risk assessment are described as well as their potential effect on the resulting risk prediction.

7.4.3.2.3 **Bioavailability.** Because the risk evaluations for metals were all based on total concentrations in soil and sediment, an unstated assumption is that each of the metals within those media are in a bioavailable form (i.e., 100 percent of the measured metal is in a form that can be taken up by plants or absorbed or assimilated through dermal contact, inhalation, or ingestion by animals). Typically, however, metals in soils or sediments occur in forms that are not bioavailable (e.g., as a solid metallic fragment, an insoluble mineral, or bound to other minerals or organic matter) and only a fraction of the total measured metal concentration is likely to be in a bioavailable form. Therefore, the assumption of 100 percent bioavailability is conservative and is likely to lead to an overestimation of the actual potential for risk.

7.4.3.2.4 **Exposure Point Concentrations.** Based upon the results of geophysical surveys and intrusive investigations, sampling of soil at the AOI was biased toward areas that were most likely to have been affected by historical use of the AOI as a target for aerial practice bombs. However, soil EPCs for this SLERA are meant to represent the entire 153 acres of upland habitat of this AOI and therefore represent the expected exposure for the average individual of the population rather than that of the maximally exposed individuals. Because, data upon which EPCs are based represent only a small fraction of the entire AOI and are biased toward the area of highest known concentration, they are likely to overestimate potential exposures in most receptors relative to the site-wide average. For this reason, it is highly likely that estimates of potential for risk represented by these EPCs also overestimate actual potential for risk from the AOI as a whole.

7.4.3.2.5 EPCs in this SLERA were represented by 95 percent UCLs of the mean of the data for specific soil depth intervals. As previously stated, the 95 percent UCLs provide a more conservative estimate of true mean concentrations in the soil than arithmetic means (i.e., the simple average). The difference between these two estimates can be seen by comparing 95 percent UCLs to arithmetic means as shown in Table 7-9. In most cases, there is little difference between these estimates; however, in the case of lead in the 2 to 12 in. depth interval, the arithmetic mean (11.3 mg/kg) is less than one half the 95 percent UCL (25.2 mg/kg), and is only marginally greater than the minimum USEPA EcoSSL of 11 mg/kg. Therefore, it's probable that the initial HQ for lead in this depth interval (2.3) is an overestimation of the true potential for risk due to the conservatively estimated EPC as based on the 95 percent UCL.

7.4.3.2.6 **Area and Seasonal Use.** For wildlife receptors, no adjustment is made to the exposure estimation for time potentially spent foraging outside of the AOI. This adjustment can be done through the application of an Area Use Factor and/or a Seasonal Use Factor to the exposure estimate (both are expressed as fractions ranging from 0 to 1). Therefore, the implicit assumption is that both of these factors are equal to 1, implying that all key wildlife species targeted in this SLERA spend the entire year confined to the area of the AOI, or more accurately, to the area of the AOI that is represented by the data (which a small fraction of the entire 153 acres and biased toward the area of greatest MC concentration). Although this assumption may be acceptable for some individuals of some species (e.g., the vole and the shrew), it is most likely highly conservative for others, such as the hawk and, most notably, the woodcock.

7.4.4 Conclusions

7.4.4.1 Based upon this SLERA, the following conclusions can be drawn:

- No high explosive compounds or their by-products occur in the soil or sediment at detectable levels; therefore, these compounds do not pose a potential risk to ecological receptors resources.
- None of the key metals (antimony, copper, lead, nickel, and zinc) occur in sediment at concentrations that exceed their corresponding ecological screening level; therefore, these metals do not pose a potential risk to ecological receptors resources.
- Copper, nickel, and zinc occur in soil at concentrations that are below their corresponding 50th percentiles of natural background and do not exceed their corresponding ecological soil screening levels. Therefore, they are likely to be within the range of natural background and are not at levels that pose a potential risk to ecological receptors resources.
- Although antimony and lead show evidence of site-related release, their potential for risk was found to be negligible based on the 95 percent UCL concentrations and (in the case of lead) a refinement of the ecological soil screening level based on less conservative exposure assumptions.

7.4.4.2 Therefore, it can be concluded that none of the MCs evaluated at the AOI pose a potential for risk to ecological receptors.

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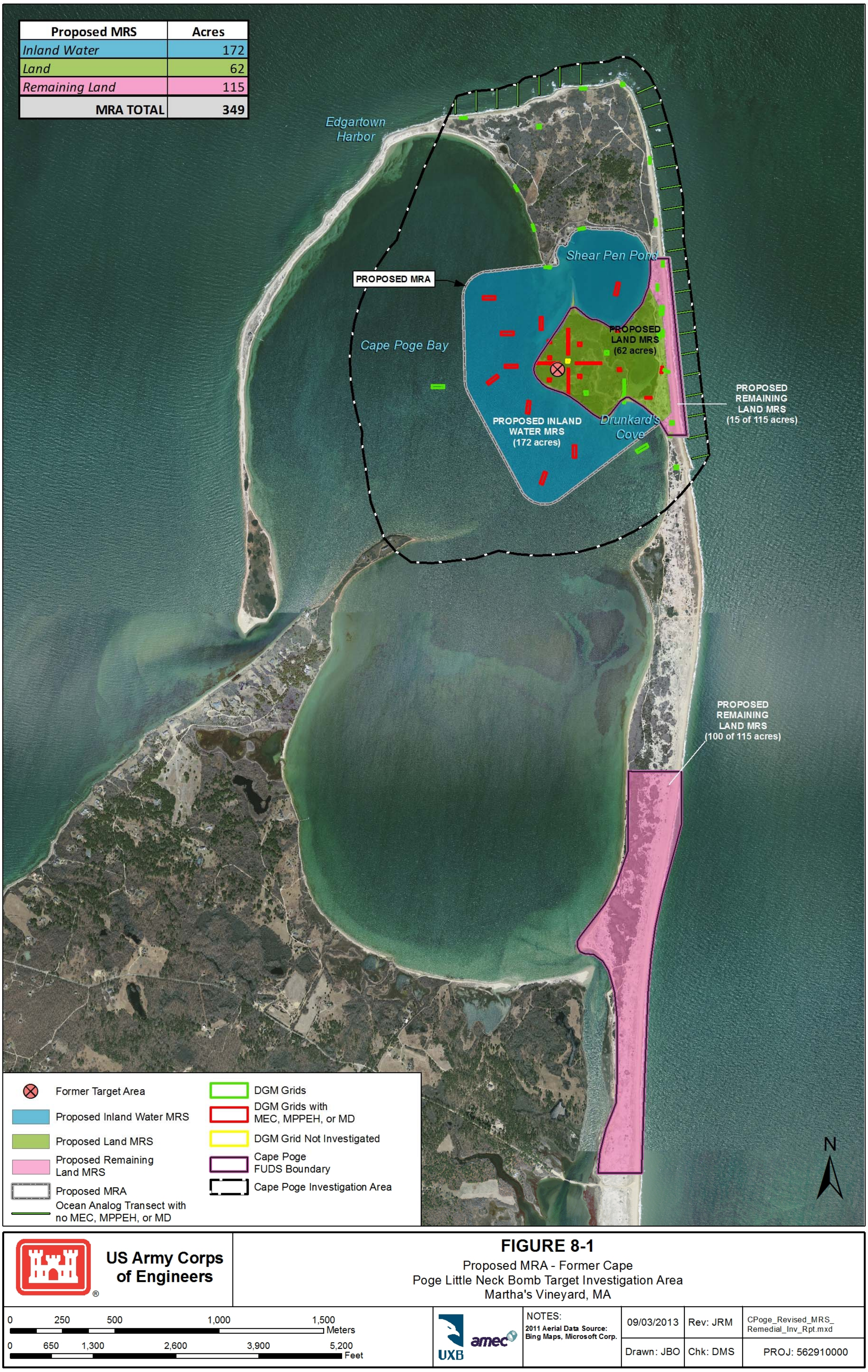
8.0 CONCLUSIONS AND RECOMMENDATIONS

8.0.1 The objective of the RI, to delineate the nature and extent of MEC, MD, and MCs impacted from historic training activities conducted at the Former Cape Poge Little Neck Bomb Target AOI, has been achieved. RI activities including geophysical surveying, intrusive investigations, and environmental sampling for analysis of MCs was conducted within land, beach, inland water, and ocean AOI sub-areas.

8.0.2 Key findings of the RI include:

- The target area was confirmed through geophysical and intrusive investigations.
- During the RI, 88 MEC items (practice bombs with spotting charges), 325 MD items, 163 non-MD items, and 5 CA items were identified.
- MEC and MD items were concentrated on Little Neck around the historic bomb target location.
- MEC and/or MD were not identified in the residential area north of Shear Pen Pond.
- The beach and ocean areas do not contain MEC or MD.
- A human health risk assessment was completed and all MCs detected were below human health screening levels. Therefore, there is no human health risk related to MCs detected at this AOI.
- Zinc occurs in soil at concentrations below the corresponding 50th percentiles of natural background and does not exceed the corresponding ecological soil screening levels. Therefore, it is likely to be within the range of natural background is not at levels that pose a potential risk to ecological receptors resources.
- Antimony and lead show evidence of potential site-related release, however, the potential for risk was found to be negligible based on the 95 percent UCL concentrations and (in the case of lead) a refinement of the ecological soil screening level based on less conservative exposure assumptions.
- Under current conditions, the MEC HA assigned a hazard level category of 2 indicating high potential explosive hazard conditions based upon the spotting charge within the AN-MK23.

8.0.3 Based upon the RI results, it is recommended that the Little Neck Bomb Target Munitions Response Area (MRA) be subdivided into three Munitions Response Sites (MRSs), comprising the land target area (62 acres), the inland water area (172 acres) and the remaining land MRS (15 acres) (Figure 8-1). As a result of the information gathered from historical records, previous investigations and the RI, a FS is recommended to evaluate future response action alternatives with regard to MEC hazards at the Little Neck Bomb Target MRA.



Proposed MRS	Acres
Inland Water	172
Land	62
Remaining Land	115
MRA TOTAL	349

Figure 8-1. Proposed MRA

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APPENDIX A

SUPPLEMENTAL STUDIES

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APPENDIX B

INSTITUTIONAL ANALYSIS AND INSTITUTIONAL ANALYSIS REPORT

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The Institutional Analysis will be provided in the Former Cape Poge Little Neck Bomb Target Area of Investigation Feasibility Study

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APPENDIX C

PERMITS

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APPENDIX D

ANALYTICAL RESULTS TABLES AND QA/QC EVALUATIONS

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APPENDIX E

FIELD FORMS

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GEOPHYSICAL DATA

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APPENDIX G

DEMOLITION ACTIVITY SUMMATION TABLES

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APPENDIX H

DOCUMENTATION OF DISPOSAL OF MUNITIONS POTENTIALLY PRESENTING AN EXPLOSIVE HAZARD, MUNITIONS DEBRIS, AND WASTES

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APPENDIX I

PROJECT PHOTOGRAPHS

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APPENDIX J

MEC HA TABLES

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