June 2015

FINAL

FEASIBILITY STUDY

FORMER SOUTH BEACH MOVING TARGET MACHINE GUN AND KATAMA ROCKET RANGE MUNITIONS RESPONSE SITE MARTHA'S VINEYARD, MASSACHUSETTS

FUDS Property No. D01MA048600
Contract No. W912DY-04-D-0019
Task Order No. 0006

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

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6/11/15

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APPENDICES

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Appendix B: Institutional Analysis
Appendix C: Cost Estimates

ACRONYMS

3Rs	recognize, retreat and report
AirMag	airborne magnetometry
Alion	Alion Science and Technology
ARAR	applicable or relevant and appropriate requirements
ARS	Archives Search Report
bgs	below ground surface
BIP	blow-in-place
CERCLA	Comprehensive Environment Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CSM	conceptual site model
DD	Decision Document
DERP	Defense Environmental Restoration Program
DGM	Digital Geophysical Mapping
DGPS	differential global positioning system
DMM	discarded military munitions
DNT	dinitrotoluene
DoD	United States Department of Defense
EM	electromagnetic
EMI	electromagnetic induction
EOD	Explosive Ordnance Disposal
EP	Engineering Pamphlet
EPA	U.S. Environmental Protection Agency
FDEMI	Frequency Domain Electromagnetic Induction
FS	Feasibility Study
ft	foot or feet
FUDS	Formerly Used Defense Site
GPS	Global Positioning System
HHRA	Human Health Risk Assessment
IC	institutional control
INPR	Inventory Project Report
LTM	long term management
LUC	land use control
MADCR	Massachusetts Department of Conservation and Recreation
MADEP	Massachusetts Department of Environmental Protection
MA NHESP	Massachusetts Natural Heritage Endangered Species Program
MC	munitions constituents
MD	munitions debris
MDAS	material documented as safe
MEC	munitions and explosives of concern
MEC HA	Munitions and Explosives of Concern Hazard Assessment
MGFD	munitions with the greatest fragmentation distance
MK	Mark
MMRP	Military Munitions Response Program

MPPEH	Material Potentially Presenting an Explosive Hazard
MRA	Munitions Response Area
MRS	Munitions Response Site
MRSPP	Munitions Response Site Prioritization Protocol
MSD	minimum separation distance
msl	mean sea level
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NG	nitroglycerin
OE	ordnance and explosives
PETN	pentaerythrite tetranitrate
PH	Priority Habitat
RAC	Risk Assessment Code
RAO	remedial action objective
RI	Remedial Investigation
SLERA	Screening Level Ecological Risk Assessment
TBC	to be considered
TCRA	Time Critical Removal Action
TDEMI	Time Domain Electromagnetic Induction
TMV	toxicity, mobility and volume
TTOR	The Trustees of Reservations
USACE	United States Army Corps of Engineers
USAESCH	United States Army Engineering Support Center, Huntsville
USC	United States Code
USDA-SCS	United States Department of Agriculture – Soil Conservation Service
USFWS	United States Fish and Wildlife Service
UU/UE	unlimited use and unrestricted exposure
UXB	UXB International, Inc.
UXO	unexploded ordnance
VRH	VRHabilis, LLC.

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1.0 EXECUTIVE SUMMARY

The United States Army Corps of Engineers (USACE) conducted a Feasibility Study (FS) at the 4,431 acre South Beach Munitions Response Area (MRA), Formerly Used Defense Site (FUDS), Property Number D01MA048600, located on Martha's Vineyard, Massachusetts to address munitions and explosives of concern (MEC). The South Beach MRA is comprised of two Munitions Response Sites (MRS); the 695 acre Former South Beach Moving Target Machine Gun and Katama Rocket Range MRS, and the 3,736 acre Remaining Ocean MRS. A Remedial Investigation (RI) was conducted from 2010 to 2011, and the results are presented under separate cover in the *Final Remedial Investigation Report for the Moving Target Machine Gun Range at South Beach Area of Investigation, Martha's Vineyard, Massachusetts* (UXB, 2014). The data collected and the conclusions drawn in the RI Report were used to develop this FS which specifically addresses the Former South Beach Moving Target Machine Gun and Katama Rocket Range at the FUDS.

Between 1943 and 1947, the MRA was used as a gunnery and rocket firing range for the 1st Naval District flight training program at Naval Air Station Quonset Point, Rhode Island and Navy Auxiliary Air Station Martha's Vineyard, Massachusetts. Military practice ordnance potentially used at the MRA include 0.30 and 0.50 caliber ammunition, 2.25 to 5 in. sub-caliber aircraft rockets, 5 in. rocket warheads, 1 to 3.5 in. rocket warheads, 3 to 3.25 in. rockets with warheads, and 3 to 3.25 in. rockets with 5 in. warheads. Since the end of military operations in 1947, numerous discoveries of munitions have been identified at the MRA by local residents, Town of Edgartown employees, and visitors.

In the Time Critical Removal Action (TCRA) and RI, no MEC was located at the Former South Beach Machine Gun and Katama Rocket Range MRS or the Remaining Ocean MRS. However, large quantities of MD were found which confirms the past usage of the site by the military as a rocket target area. Practice rockets that have been identified and documented on site include 5-inch MK6 warheads that have been plaster filled; however, there is an explosive counterpart that looks similar to the practice rocket warhead. EOD and/or the State Bomb Squad have and will continue to respond to munitions finds at this site. Their reports are inconclusive in the findings as to whether there was any contribution to the detonation of these rocket motor bodies and warheads. Therefore, based on the history of the site, related sites, results of previous actions and the RI, coupled with the large volume of munitions items found and large volume of receptors at the site, there remains a small risk of encountering MEC in at this site.

Between November 1988 and May 1989, a removal action was conducted within the MRS, which concentrated in areas encompassing beaches and sand dunes. During the removal action, approximately 1,655 MD items were successfully recovered with approximately 99 of those items being inert/dummy warheads. Between 18 April and 25 September 2009, a Time Critical

Removal Action (TCRA) was conducted within the ocean portion of the MRS. During clearance operations, 617 MD items and 933 pounds of non-MD were removed.

During the RI, two MD items were observed on land and beach and 96 MD items were recovered in the ocean portion of the 695-acre MRS. The RI included a finding that there was a low statistical potential for MEC to be present and therefore a MEC source or explosive hazard is possible in the MRS. The significant amount of MD within the MRS and the high volume of receptors indicates that munitions will continue to be encountered at this site in the future. Based on not finding MEC during the RI, a MEC Hazard Assessment (HA) was not performed for either MRS.

Between October and November 2011, environmental sampling for munitions constituents (MC) was conducted at the Investigation Area, which included the collection of discrete, biased surface and subsurface soil samples and groundwater samples. Samples were analyzed for MCs, including antimony, copper, lead, nickel, and zinc, and explosive compounds previously identified as components of munitions identified within the Investigation Area. Analytical results indicated that lead is present at concentrations exceeding ecological screening criterion at three soil sample locations, but below the human health screening criterion at all locations. All other detections of metals and explosives in soil and groundwater were below human health and ecological screening criterion.

A Human Health Risk Assessment (HHRA) and a Screening-Level Ecological Risk Assessment (SLERA) were performed during the RI. In accordance with CERCLA related HHRA guidance, no COPCs were identified within the MRS. Therefore, no further human health risk evaluation is required. There is no unacceptable risk to human health due to MC. All detected concentrations are less than the applicable Method 1 standards. Although concentrations of lead in surface soil exceeded the USEPA Eco-SSL for that metal, its potential for risk was found to be negligible based on the 95% UCL concentration for the 2-12 in. soil depth interval and a refinement of the ecological soil screening level based on less conservative exposure assumptions for the 0-2 in. depth interval. Therefore, it can be concluded that none of the MCs evaluated at the MRS pose a potential for risk to ecological receptors.

No action is recommended for the Remaining Ocean MRS following the RI since the insignificant amount of MD (2 practice rockets) within the MRS and the lack of exposure to receptors due to the lack of finds at these deeper areas indicates that munitions will not be encountered at this site in the future. The MRS primarily consists of ocean 300 to 600 feet beyond the mean low water mark. A FS was recommended for the Former South Beach Moving Target Machine Gun and Katama Rocket Range MRS to address the fact that property users will continue to encounter munitions in the future and a MEC source or explosive hazard is possible. Although munitions recovered in the future will likely be inert, this determination should only be made by trained authorities. No further action was identified associated with MCs at the Former

South Beach Moving Target Machine Gun and Katama Rocket Range MRS since it was determined that no unacceptable current or future risk exists for human health or ecological receptors.

The purpose of this FS is to identify, develop, and perform a detailed analysis of potential remedial alternatives that would meet the remedial action objective (RAO) so that the decision-makers will have adequate information to select the most appropriate remedial alternative(s) for the Former South Beach Moving Target Machine Gun and Katama Rocket Range MRS.

The following major steps were involved in the development of this FS:

- Identification of RAOs.
- Identification of Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered information (TBCs).
- Identification of general response actions.
- Identification and screening of potentially applicable remedial technologies and process options for the general response actions.
- Development and screening of a range of remedial alternatives for the site based on the combinations of the remedial technologies that were retained.
- Performance of a detailed analysis for each of the remedial alternatives using the evaluation criteria required by the National Oil and Hazardous Substances Pollution Contingency Plan (NCP).
- Identification of the most appropriate and viable remedial alternative(s) that meet the RAO.

This FS evaluates the appropriateness and effectiveness of potential remedial alternatives to achieve the following RAO:

> *To reduce the probability of the public from handling munitions encountered during residential, construction/maintenance, and recreational activities performed at ground surface, in subsurface soil to 4 feet below ground surface, and in the area of breaking waves, or the ocean surf zone.*

The RAO facilitates the development of alternatives for the Former South Beach Moving Target Machine Gun and Katama Rocket Range MRS and focuses the comparison of acceptable remedial action alternatives. The RAO also assists in clarifying an acceptable level of protection for human health and the environment. These objectives are required to meet NCP criteria.

General response actions are those actions that are evaluated to achieve the RAO. General response actions considered for the Former South Beach Moving Target Machine Gun and

Katama Rocket Range MRS include Land Use Controls (LUCs) and munitions clearance activities. In accordance with FUDS program guidance, the term LUCs encompasses physical, legal, or administrative mechanisms that restrict the use of, or limit access to, contaminated property to reduce risks to human health and the environment. munitions clearance activities include technologies used for detection, positioning, removal, disposal, and waste stream treatment (if necessary). The various LUC components and clearance technologies currently available to address munitions were screened for effectiveness, implementability, and cost to assess the viability of each technology at the MRS and to provide additional information to future decision-makers.

The following remedial alternatives were developed from the general remedial actions identified above and were evaluated for the Former South Beach Moving Target Machine Gun and Katama Rocket Range MRS:

- Alternative 1 – No Action: A "no action" alternative is required by the NCP to be developed during a FS to provide a baseline for comparison against other contemplated alternatives. In Alternative 1, the government would take no action with regard to locating, removing, and disposing of any potential munitions present within the Former South Beach Moving Target Machine Gun and Katama Rocket Range MRS.

- Alternative 2 – LUCs: The alternative involves the implementation of LUCs based on public awareness and education components to provide a means to reduce munitions encounters by workers and recreational users and visitors (i.e., unqualified personnel) through behavior modification.

- Alternative 3 – Land Area Only Subsurface Clearance with LUCs (309 Acres): Alternative 3 includes removal of subsurface munitions to 4 feet below ground surface on the beach and land portions of the MRS. LUCs would be implemented on the remaining inland water and beach areas.

- Alternative 4 – Complete Subsurface Clearance Land and Water (695 Acres). Alternative 4 includes clearing munitions to 4 feet below ground surface over the land, beach, and ocean portions of the MRS.

In accordance with DoD Manual 4715.20 (DoD, 2012), a minimum of three alternatives for each MRS are required. One alternative must consider no action alternative, a second must consider an action to remediate the site to a condition that allows unlimited use/unrestricted exposure (UU/UE), and a third alternative will consider an action to remediate the site to a protective condition that requires LUCs. Alternative 1 meets the requirement for a no action alternative. Alternatives 2 and 3 meet the requirement for an alternative with LUCs, and Alternative 4 meets the requirement for an alternative that will achieve UU/UE.

The remedial alternatives were deemed viable for use at the MRS and were assessed in a detailed evaluation against seven of the nine the criteria described in the NCP, Section 300.430. The nine evaluation criteria are:

1. Overall protectiveness of human health and the environment;
2. Compliance with ARARs;
3. Long-term effectiveness and permanence;
4. Reduction of toxicity, mobility, or volume of contaminants through treatment;
5. Short-term effectiveness;
6. Implementability;
7. Cost;
8. State acceptance; and,
9. Community acceptance.

State acceptance and community acceptance will be evaluated after receipt of comments on the Proposed Plan.

Based on the detailed analysis of remedial alternatives, the strengths and weaknesses of the remedial alternatives relative to one another were evaluated with respect to each of the NCP criteria. The results of this comparative analysis for the MRS are summarized in Table 1-1. This approach to analyzing alternatives is designed to provide decision-makers with sufficient information to adequately compare the alternatives, select an appropriate remedy for the MRS, and demonstrate satisfaction of the Comprehensive Environmental Response, Compensation, and Liability Act remedy selection requirements in the Decision Document.

For the Former South Beach Moving Target Machine Gun and Katama Rocket Range MRS, Alternative 2: LUCs most favorably meets all of the evaluated detailed analysis criteria as compared to Alternatives 1, 3, or 4. Alternative 2 can be readily implemented and would provide a high level of protectiveness over the long-term compared to its cost, whereas Alternatives 3 and 4 are more difficult to implement and would incur a much greater cost for only a slightly higher level of protectiveness over the long term.

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Table 1-1. Comparative Analysis Summary, Former South Beach Moving Target Machine Gun and Katama Rocket Range MRS Alternatives

Potential Remedial Alternative	Overall Protectiveness of Human Health and the Environment	Compliance with ARARs	Long-Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, or Volume (TMV) of Contaminants Through Treatment	Short-Term Effectiveness	Implementability	Cost[1]	State and Community Acceptance
Alternative 1: No Action	Alternative 1 would not be protective because no action would be taken to reduce exposure to MEC.	There are no ARARs associated with Alternative 1.	Alternative 1 would not be effective or permanent.	Alternative l would not reduce the TMV of MEC.	There would be no additional risk to the community or workers because there are no construction or operation activities associated with Alternative 1, and it would require no time to complete.	Alternative 1 is easily implementable.	$0	TBD
Alternative 2: Land Use Controls (LUCs)	Alternative 2 would be protective through controlling exposure to possible receptors through LUCs.	There are no ARARs associated with Alternative 2.	Alternative 2 would be protective since it controls exposure through LUCs. However, it relies on exposure control rather than removal or treatment.	Alternative 2 would not reduce the TMV of MEC.	There would be no additional risk to workers, residents or the environment because there are no construction intrusive activities associated with Alternative 2. Approximately 6 months would be required to establish LUCs associated with Alternative 2.	Alternative 2 is easily implementable for the types of LUCs that were retained for consideration.	$621,000	TBD
Alternative 3: Partial Subsurface Clearance with LUCs	Alternative 3 provides protectiveness through a combination of MEC removal and LUCs controlling exposure to possible receptors.	Alternative 3 would be implemented to comply with ARARs.	Under Alternative 3, all munitions would be destroyed within the land and beach portion of the MRS, but would still require LUCs in the long-term.	Alternative 3 would be effective in the reduction of TMV through removal of all MEC within the land and beach portions of the MRS and would satisfy the statutory preference for treatment as a principal element of the remedy because MEC would be destroyed.	Implementation of Alternative 3 will increase in risk to workers and the environment since the work involves exposure to potentially explosive items. These risks would be mitigated through use of SOPs for conducting MEC removals. Impacts to local residents and the public may occur, but would be temporary and limited to the immediate work area. Some vegetation clearance is anticipated, therefore impacts to the environment are possible. Procedures for minimizing, reducing or mitigating negative effects would be developed in the Remedial Action Work Plan. It is estimated that partial clearance under Alternative 3 would require approximately 6 months of field work to implement and 6 months would be required to establish LUCs.	Alternative 3 would be easily implemented at the MRS. Removal of munitions within the MRS was implemented effectively during the TCRA and RI. Coordination with TTOR, MADCR, and the Town of Edgartown is required for this alternative.	$8,885,000	TBD
Alternative 4: Subsurface Clearance	Alternative 4 provides protectiveness by removing the MEC hazard at the MRS.	Alternative 4 would be implemented to comply with all ARARs.	Alternative 4 would remove MEC hazards from within the entirety of the MRSs and would be the most effective and permanent remedial alternative over the long-term because it would eliminate risk regardless of the future use of the property.	Alternative 4 would be the most effective in reducing the TMV of MEC because all detectable MEC throughout the entirety of the MRS would be destroyed and would satisfy the statutory preference for treatment as a principal element.	Implementation of Alternative 4 will increase in risk to workers and the environment since the work involves exposure to potentially explosive items. These risks would be mitigated through use of SOPs for conducting MEC removals. Impacts to local residents and the public may occur, but would be temporary and limited to the immediate work area. Some vegetation clearance is anticipated, therefore impacts to the environment are possible. Procedures for minimizing, reducing or mitigating negative effects would be developed in the Remedial Action Work Plan. It is estimated that clearance under Alternative 4 would require approximately 12 months of field work.	Alternative 4 would take longer to implement than Alternative 3 as it would be performed over a large area and would require intrusive ocean work. Alternative 4 would be slightly more difficult to implement because of the additional administrative work required as a result of the length of the clearance compared to Alternative 3. Coordination with TTOR, MADCR, and the Town of Edgartown is required for this alternative.	$16,048,000	TBD

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2.0 INTRODUCTION

This report documents the results of a Feasibility Study (FS) conducted within the South Beach Munitions Response Area (MRA) Property Number D01MA048600, located on Martha's Vineyard, Massachusetts for munitions and explosives of concern (MEC) (see Figure 2-1). This FS was performed in support of the Department of Defense (DoD) Military Munitions Response Program (MMRP). UXB International, Inc. (UXB) was authorized to conduct the FS through a United States Army Engineering Support Center, Huntsville (USAESCH) Contract, No. W912DY-04-D-0019, Task Order No. 006. The FS was conducted in accordance with the procedures established for managing and executing military munitions response actions in Draft Engineer Pamphlet No. 1110-1-18 (United States Army Corps of Engineers [USACE], 2006), as directed in the Revision 4 Performance Work Statement dated 24 March 2014 and, with respect to Engineer Regulation 200-3-1 (USACE, 2004), which provides the specific policy and guidance for management and execution of the FUDS program.

The remedial alternatives designed and evaluated in detail and comparatively in this FS address one Munitions Response Site (MRS) within the South Beach MRA: the Former South Beach Moving Target Machine Gun and Katama Rocket Range MRS (695 acres). The MRS boundary is depicted on Figure 2-2.Figure 2-3 details the Former South Beach Moving Target Machine Gun and Katama Rocket Range MRS. The results of the Remedial Investigation (RI) are documented in the *Final Remedial Investigation Report for the Former Moving Target Machine Gun Range at South Beach Area of Investigation, Martha's Vineyard, Massachusetts* (UXB, 2014).

In the Time Critical Removal Action (TCRA) and RI, no MEC was located at the Former South Beach Machine Gun and Katama Rocket Range MRS or the Remaining Ocean MRS. However, large quantities of MD were found which confirms the past usage of the site by the military as a rocket target area. Practice rockets that have been identified and documented on site include 5-inch MK6 warheads that have been plaster filled; however, there is an explosive counterpart that looks similar to the practice rocket warhead. EOD and/or the State Bomb Squad have and will continue to respond to munitions finds at this site. Their reports are inconclusive in the findings as to whether there was any contribution to the detonation of these rocket motor bodies and warheads. Therefore, based on the history of the site, related sites, results of previous actions and the RI, coupled with the large volume of munitions items found and large volume of receptors at the site, there remains a small risk of encountering MEC in at this site.

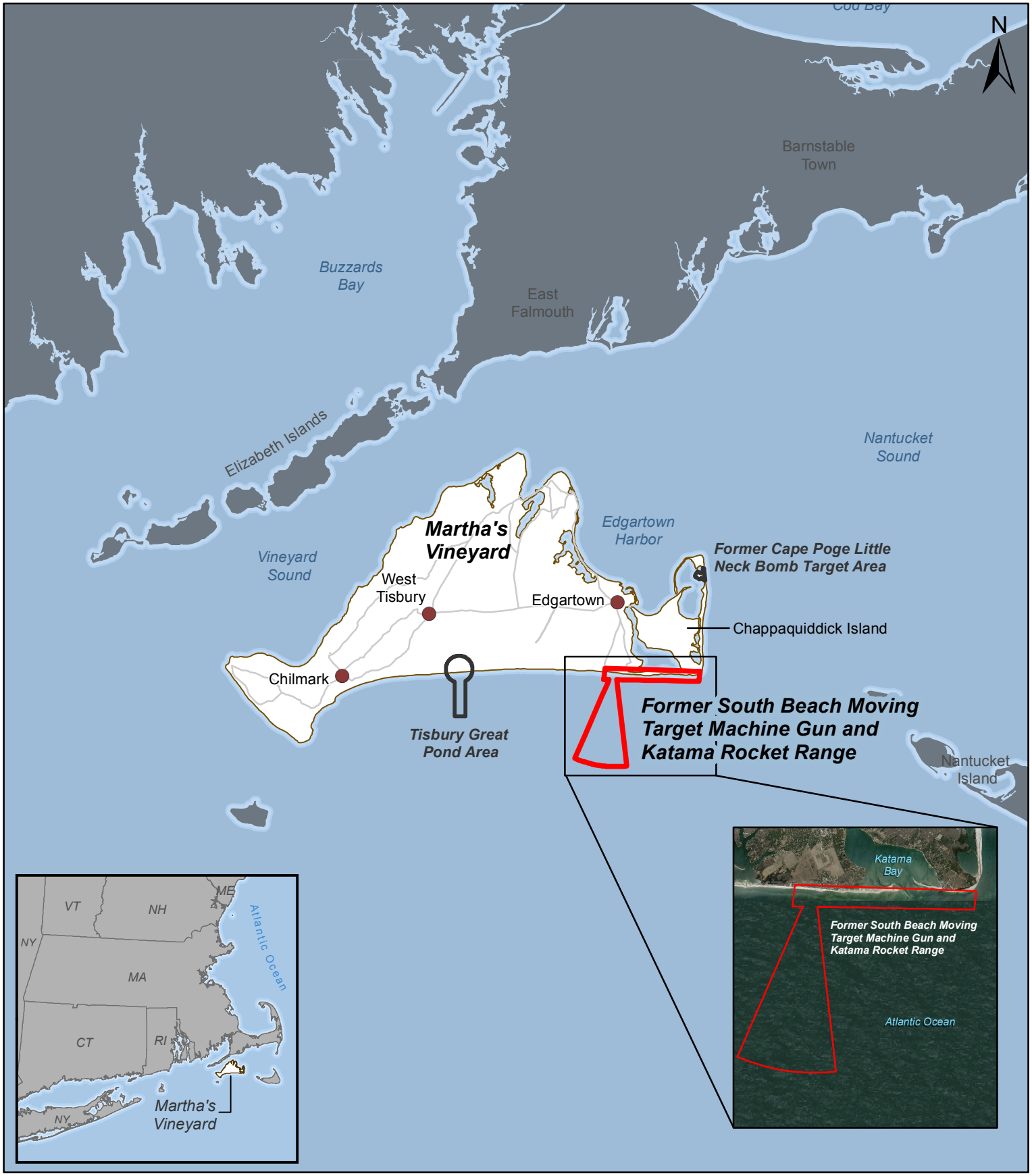
No action is recommended for the Remaining Ocean MRS following the RI since the insignificant amount of MD (2 practice rockets) within the MRS and the lack of exposure to receptors due to the lack of finds at these deeper areas indicates that munitions will not be encountered at this site in the future. The MRS primarily consists of ocean 300 to 600 feet

beyond the mean low water mark. A FS was recommended for the Former South Beach Moving Target Machine Gun and Katama Rocket Range MRS to address the fact that property users will continue to encounter munitions in the future and a MEC source or explosive hazard is possible. Although munitions recovered in the future will likely be inert, this determination should only be made by trained authorities. No further action was identified associated with MCs at the Former South Beach Moving Target Machine Gun and Katama Rocket Range MRS since it was determined that no unacceptable current or future risk exists for human health or ecological receptors.

The RI/FS process was developed in response to Comprehensive Environment Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986. This FS was performed to be consistent with the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) and the U.S. Environmental Protection Agency (EPA) document, *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA, 1988).

2.1 **Purpose**

The purpose of the FS for the Former South Beach Moving Target Machine Gun and Katama Rocket Range MRS is to identify, develop, and perform a detailed analysis of potential remedial alternatives that would meet the remedial action objective (RAO) and thus afford the decision-makers adequate information to select the most appropriate remedial alternative(s) for the MRS. The selected alternative is expected to mitigate, reduce, or eliminate unacceptable risks to human health and the environment from MEC at the MRS based on the current and intended future use of the property.



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

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NOTES:
Base map data source: ESRI

4/13/2015	Rev:	SBeach_MV_Island_FS.mxd	
Drawn: JBO	Chk: DMS	PROJ: 562910000	

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MRS	Acres
Former South Beach Moving Target Machine Gun and Katama Rocket Range	695
Remaining Ocean	3,736
MRA TOTAL	**4,431**

N

Katama Airpark

Katama Farm

Katama Bay

Pocha Pond

Wasque Point

FORMER SOUTH BEACH MOVING TARGET MACHINE GUN AND KATAMA ROCKET RANGE MRS (695 acres)

REMAINING OCEAN MRS (3,736 acres)
(SEE AREAL OVERVIEW INSET FOR FULL EXTENT)

Atlantic Ocean

AREAL OVERVIEW

0 1 2 Miles

Former Rocket Target

MRA Boundary

Proposed Former Machine Gun and Katama Rocket Range MRS

Proposed Remaining Ocean MRS

South Beach FUDS Boundary

South Beach Investigation Area

US Army Corps of Engineers

FIGURE 2-2

Former South Beach Moving Target Machine Gun and Katama Rocket Range MRS, Martha's Vineyard, MA

0 200 400 800 1,200 Meters

0 750 1,500 3,000 4,500 Feet

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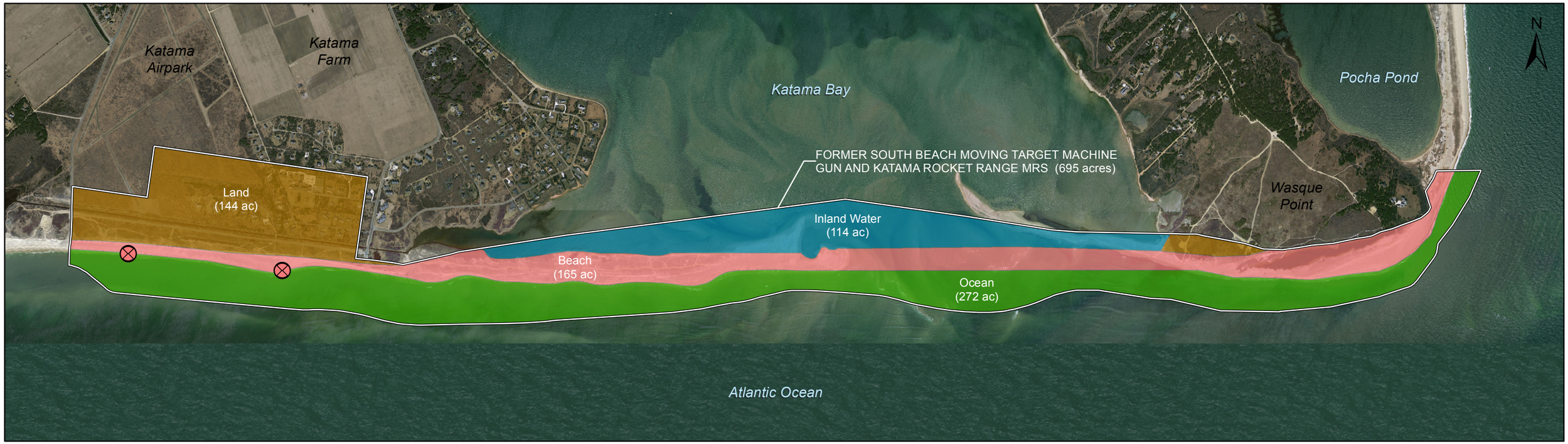
NOTES:
2009 Aerial Data Source: MassGIS

4/13/2015	Rev:	SBeach_Revised_MRS_FS.mxd	
Drawn: JBO	Chk: DMS	PROJ: 562910000	



Former Rocket Target

MRS Divisions:

Beach

Inland Water

Land

Ocean

US Army Corps of Engineers

FIGURE 2-3

Former South Beach Moving Target Machine Gun and Katama Rocket Range MRS, Martha's Vineyard, MA

0 200 400 800 1,200 1,600 Meters

0 750 1,500 3,000 4,500 Feet

UXB amec

NOTES:
2009 Aerial Data Source: MassGIS

04/13/2015	Rev:	SBeach_Revised_MRS_Divided_FS.mxd	
Drawn: JBO	Chk: DMS	PROJ: 562910000	

Only properties transferred from DoD control before 17 October 1986 are FUDS eligible. The Army is the executive agent for the FUDS program, and USACE is the programs executing agent USACE must comply with the Defense Environmental Restoration Program (DERP) statute (10 United States Code [USC] 2701 et seq.), CERCLA (42 USC § 9601 *et seq.*),Executive Orders 12580 and 13016, the NCP, and all applicable DoD (e.g., Engineering Pamphlet [EP] 1110-1-18, ER 200-3-1, *Management Guidance for the DERP* [DoD, 2012]) and Army policies in managing and executing the FUDS program (USACE, 2004). The FUDS program addresses MEC, including unexploded ordnance (UXO), discarded military munitions (DMM), and munitions constituents (MC) located on former defense sites under the MMRP, established by the U.S. Congress under DERP.

The RI included a finding that there was a low statistical potential for MEC to be present and therefore a MEC source or explosive hazard is possible in the MRS. The significant amount of MD within the MRS and the high volume of receptors indicates that munitions will continue to be encountered at this site in the future. A FS was recommended following the RI to address the 695 acre Former South Beach Moving Target Machine Gun and Katama Rocket Range MRS (UXB, 2014). The following major steps are involved in the development of the FS:

- Identification of Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered information (TBCs) (Section 3).
- Identification of general response actions (Section 4).
- Identification of RAOs (Section 4).
- Identification and screening of potentially applicable remedial technologies and process options for the general response actions (Section 4).
- Development and screening of a range of remedial alternatives for the MRSs based on combinations of the remedial technologies that were retained (Section 5).
- Performance of a detailed analysis for each of the remedial alternatives using the evaluation criteria as required by the NCP (Section 6).
- Identification of the most appropriate remedial alternative(s) that meet the RAO through a comparative analysis of all remedial alternatives using the NCP criteria (Section 6).

2.2 Historical Information

The following subsections provide a summary of the MRA background and history and previous investigations, including the RI, that have been conducted within the MRA.

2.2.1 Munitions Response Area Background

In 1944, the Department of the Navy acquired leases on approximately 264 acres at South Beach. The leases were acquired for the purpose of a gunnery and rocket firing range for the 1st Naval District flight training program at Naval Air Station Quonset Point, Rhode Island and Navy Auxiliary Air Station Martha's Vineyard, Massachusetts. An oval-shaped moving target track, three fixed machine gun firing lines, two rocket targets, a Target Car Shelter, and other support features were constructed near the ocean (Figure 2-4). Two fixed machine gun firing lines, located north of the moving target track, were used to fire ammunition at targets that traveled along the oval-shaped track. The third fixed machine gun range, located northeast of the moving target range, was used to fire ammunition at targets placed in front of a soil impact berm. The two rocket targets, located on the eastern and western side of the moving target track, were used by pilots to practice their rocket firing skills. The site remained active until 1947 when the U.S. Navy approved the discontinuance of the site. Following closure of the site, the moving target track was removed (USACE, 2010).

The Target Car Shelter that was built at the former range was swept into the ocean due to erosion and is now located approximately 500 ft off-shore. In 1983, an attempt was made by a Massachusetts State Trooper to demolish the Target Car Shelter. According to internal correspondence between Town of Edgartown personnel, a combination of plastic explosives (C-3 or C-4) and dynamite were used in an attempt to demolish the Target Car Shelter (Edgartown).

Military practice ordnance used at the MRA included:

- 2.25 to 5 in. sub-caliber aircraft rockets, 5 in. rocket warheads
- 1 to 3.5 in. rocket warheads
- 3 to 3.25 in. rockets with warheads, and
- 3 to 3.25 in. rockets with 5 in. warheads.

Records do not indicate that the property was ever used to store, transport, treat, or dispose of associated munitions used on the property. Prior to the RI, two 100 lb bombs of an unknown source, were reported at Wasque Point, however, there is no supporting evidence that they were associated with historical operations at South Beach.

2.2.2 Previous Investigations

Investigations conducted at the South Beach MRA prior to the 2011 RI include:

- Ordnance and Explosive Waste Remediation Project, USACE (1988);
- Unexploded Ordnance (UXO) Removal, Department of the Army [Explosive Ordnance Disposal (EOD)] (1989);
- Inventory Project Report (2008);

- Time Critical Removal Action (TCRA) (2009);
- Emergency Response, VRH (2008 to 2011); and
- Emergency Response, UXB (2012).

2.2.2.1 Unexploded Ordnance Removal

Between November 1988 and May 1989, a UXO removal action was conducted within the MRA, which concentrated in areas encompassing beaches and sand dunes (Figure 2-8). During the removal action, approximately 1,655 MD items were successfully recovered with approximately 99 of those items being warheads. As part of this removal action, the beaches and sand dunes where intrusive activities occurred were restored (Army, 1989).

2.2.2.2 Inventory Project Report

In 2008, the USACE prepared an Inventory Project Report (INPR) in support of the Defense Environmental Restoration Program (DERP) for FUDS. The Findings and Determination of Eligibility (FDE) established an area from South Beach to Wasque Point as a FUDS. A Military Munitions Response Program (MMRP) project was proposed and the INPR identified a MEC category hazard potential. A MRSPP priority ranking was deferred and was to be scored based on the finding of the proposed TCRA (USACE, 2008c).

2.2.2.3 Time Critical Removal Action

Between 18 April and 25 September 2009, a TCRA was conducted within the MRA (USACE, 2010) to remove MEC, Material Potentially Presenting an Explosive Hazard (MPPEH), and explosive hazards at the site.

The removal action was conducted on approximately 22 acres within the MRA, which 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. Anomalies identified by the magnetometer were investigated and removed using hand tools and mechanical equipment.

During clearance operations, 617 MD items and 933 pounds of non-MD were removed. These items included 2.25 to 3.5 in. rocket motors, a 3 in. rocket motor with a 5 in. warhead, a 3.5 in. rocket motor with a 5 in. warhead, and 3.5 to 5 in. warheads. In addition to clearance operations, five demolition events were performed at South Beach in which 42 items were perforated and found to be inert (USACE, 2010).

2.2.2.4 Emergency Response

Between May 2008 and August 2011, VRH responded to four emergency calls associated with potential ordnance. The EOD incident reports from May 2008 state that a 100 pound bomb suspected of containing high explosives was detonated. Due to the mission of the EOD to render items safe by detonation (as opposed to perforating the items to first determine whether the items contain explosives) coupled with the large amount of explosives used by the EOD team, USACE has concluded that it is highly unlikely and extremely difficult to determine if an item was MD or MEC after detonation. The details of this emergency response and others are presented in Table 2-1, and the emergency response reports are included in Appendix A of the RI Report (UXB, 2014).

Table 2-1. Emergency Responses
Former South Beach Moving Target Machine Gun Range MRS

Date	Location	Quantity	Ordnance Description	Response Action
05-2008[(1)]	Wasque Point	1	100-pound bomb (suspected of containing HE)	Massachusetts Bomb Squad detonated the bomb. Based upon the detonation, the bomb was suspected of being live ordnance.
26-08-2008[(2)]	South Beach	8	• 41.5-in. x 3.125-in. rocket motor • 38.5-in. x 3.125-in. rocket motor • 25.5-in. x 2.75-in. rocket motor • 24.5-in. x 2.75-in. rocket motor • 22.5-in. x 2.75-in. rocket motor • 24.75-in. x 2.75-in. rocket motor • 26-in. x 2.75-in. rocket motor • 6-in. x 2.75-in. rocket motor	n/a
13-02-2009[(2)]	Wasque Point	1	100-pound bomb	VRH identified item as ordnance and secured the immediate area. The Massachusetts Bomb Squad and Navy EOD were notified. Navy EOD detonated the bomb and determined that the bomb likely contained incendiary compounds when observing the resulting explosion.
1-08-2011[(2)]	Norton Point	1	2.25-in. rocket motor	VRH personnel determined the item to be free of hazardous/ energetic material and was removed to a secure container.
2-17-12[(3)]	South Beach	1	5-in. MK6 practice warhead	UXB personnel determined that the item was safe to move for detonation. The warhead was moved to South Beach at the entrance to Norton Point and detonated. The item was determined to be a MD item.

Notes: [(1)] Information obtained in the Amended Findings and Determination of Eligibility, South Beach at Martha's Vineyard, (Moving Target Machine Gun Range) (USACE, 2008c).
[(2)] Information obtained from VHR Emergency Response Reports (VHR, 2008; 2009; and 2011).
[(3)] Information obtained from UXB Daily Report (UXB, 2012).

EOD - explosive ordnance disposal **in.** - inch(es) **MD** - munitions debris **VRH** - VRHabilis, LLC

2.3 Summary of Remedial Investigation Results

This section provides a summary of the results of the RI conducted to characterize the MRS and determine the nature and extent of MEC hazards and MC risks. Field activities were conducted at the MRA, to achieve the project Data Quality Objectives established in the *Final Remedial Investigation Work Plan* (UXB, 2011), and to determine if further action is required under the CERCLA process.

2.3.1 RI Findings

To characterize the nature and extent of MEC, various field investigative activities were conducted including geophysical surveying and intrusive investigations. 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:

- Digital Geophysical Mapping (DGM) transects on the beach and dune areas where no vegetation clearing was required; and,
- Analog magnetometer survey and intrusive investigation (mag and dig) ocean transects.

This work was supplemented with an airborne magnetometry (AirMag) survey performed using a magnetometer 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.

Data collected during the wide area assessment was subsequently used to identify 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, 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-six DGM grids were located within the MRA. Geophysical data were collected in the grids by towing the electromagnetic (EM) sensor system by hand. DGM data collected within the grids were evaluated and a list of anomalies to be intrusively investigated was generated.

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 beach locations were conducted by UXO technicians. 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. Once identified, debris was classified as non-MD, cultural artifacts, MD, or MEC. During the intrusive investigation, 97 MD items and 98 non-MD items were identified. No MEC items were identified during the field investigation. MD items included 2.25 to 5 in. sub-caliber aircraft rockets, 5 in. rocket warheads, 1 to 3.5 in. rocket warheads, 3 to 3.25 in. rockets with warheads, and, 3 to 3.25 in. rockets with 5 in. warheads. MD items discovered during the intrusive investigation were removed, and properly disposed.

Within beach and land portions of the MRA, MD was found between 6 inches and 2 feet below ground surface (bgs). In the ocean portions of the MRA, MD was found between the surface and up to 4 feet depth from the ocean floor during the TCRA. 100% of the total quantity of MD recovered was discovered within the subsurface.

2.3.2 Ocean Transport Study

To better understand the movement of MD or potential MEC items in the surf zone and support the characterization of nature and extent of MEC at the MRA, an ocean transport study was conducted. The study was conducted during several mobilizations, including a MEC transport grid survey conducted from June 16 through 22, 2010 and a storm event follow-up survey October 4 through 20, 2010. In addition, a MEC transport acoustic transponder (pinger) survey was conducted from October 21 through November 9, 2010. The objectives of the study were to:

1. Determine whether MPPEH can be transported by ocean waves;
2. Determine the area within the coastal surf zone where wave-driven MPPEH transport is most likely to occur; and,
3. Determine whether prevailing wave-induced erosion is likely to continue exposing and transporting MPPEH if any remain buried under the existing beach; if so, determine the sections of beach that might be most vulnerable.

The surveys were conducted by UXO divers using analog geophysical instruments. A summary of the activities conducted during the ocean transport study are presented below the complete transport study report is included as Appendix A in the RI Report.

MEC Transport Grid Surveys – The purpose of this portion of the ocean transport study was to determine if additional items had migrated into the previously cleared grids, and what effect storm events may have on this migration. To accomplish this, two one-acre grids were established, within the previous TCRA Grids 5/6 and 18/19 (Figure 4-3), where the majority of MD items were removed. These grids were surveyed in June 2010 to determine the number of anomalies that were initially present. Following a storm event in October 2010, a second survey

was conducted to determine if the anomalies had moved positions and whether new anomalies were present.

MEC Transport Acoustic Transponder (Pinger) Survey – The Transport Acoustic Pinger Survey was conducted to determine the area within the coastal surf zone where wave-driven MPPEH transport is most likely to occur. Eight acoustic target transponders (pingers) were placed within TCRA Grids 5/6 and 18/19. Each grid was seeded with 4 rocket stimulants and each seed was fitted with a pinger for tracking purposes. At the conclusion of the field operations, the seeds were interrogated.

2.3.3 ESTCP Characterization

The ESTCP, commensurate with its mission to develop standardized and effective data collection methods at munitions contaminated sites, initiated a project to develop and demonstrate a WAA technique for locating and delineating munitions-like objects in marine condition environments. In a cooperative effort, the USACE and the ESTCP combined their resources with a plan wherein the data collected during the ESTCP WAA demonstration could be used to augment the information being collected as part of this RI. The fundamentals of that plan would be that ESTCP would conduct its WAA study in an area useful to the RI and would be incorporated into the RI CSM.

The objective of the ESTCP WAA was to address the lack of effective and proven approaches for conducting WAA at sites where MEC may be present underwater. The objective of the USACE RI portion of the study was to provide divers trained and certified in EOD related activities to conduct underwater investigations potentially involving MPPEH/MEC. The diver's objectives included assisting Tetra Tech EC, Inc. (TtEC) with dive-related activities during the installation of an IVS, and completing the validation of the ESTCP WAA results.

The ESTCP completed their WAA demonstration over a rectangular area of the Atlantic Ocean approximately 12,500 ft long (approximately 2.3 miles) in the long-shore direction and approximately 9,800 ft long (approximately 1.8 miles) in the off-shore direction. TtEC collected magnetic gradiometer array (MGA) along 29 parallel, east-west transects totaling 7.1 kilometers in length (23,294 ft).

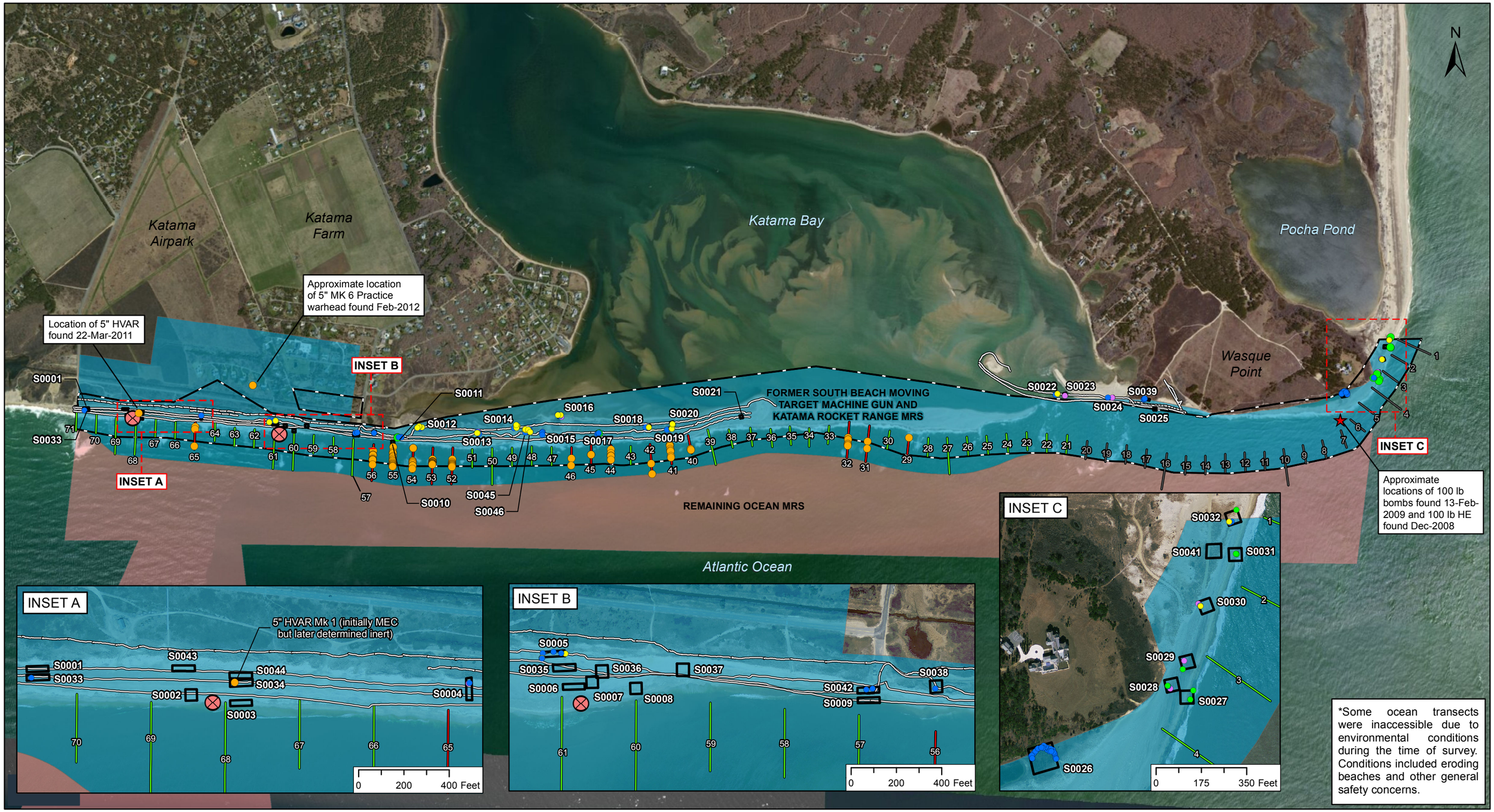
2.3.4 Munitions Constituents

Between October 13 and October 15, 2011, one incremental soil (0 to 2 in. bgs), 33 discrete surface soil (2 to 12 in. bgs), and 33 discrete subsurface soil (12 to 18 in. bgs) samples were collected for environmental sampling for MCs at the MRA. On November 2, 2011, 3 groundwater samples were collected. Sample locations are shown on Figure 2-5. Samples were analyzed for MCs, including antimony, copper, lead, nickel, and zinc, and explosive compounds,

including pentacrythrite tetranitrate (PETN) and nitroglycerin (NG), previously identified as components of munitions identified within the area. Analytical results indicated that lead is present at concentrations exceeding ecological screening criterion at three soil sample locations, but below the human health screening criterion. All other detections of metals in soil and groundwater were below human health and ecological screening criterion. No explosives were detected in soil samples. In groundwater, 2-nitrotoluene, 3-nitrotoluene, and 4-nitrotoluene were detected in one sample; however, their concentrations were below human health screening criterion. No other explosives were detected in groundwater samples.

Human Health Risk Assessment (HHRA) was conducted for the MRA to provide a comprehensive assessment of potential risks to individuals that may be exposed to hazardous constituents at the MRA. The HHRA concluded that there is no current or potential future unacceptable risk to human health from MC at Former South Beach Moving Target Machine Gun and Katama Rocket Range MRS.

A SLERA was performed to evaluate risks posed to ecological receptors (plants, invertebrates, herbivores, predators, and marine receptors) due to exposures to residual MCs. Although concentrations of lead in surface soil exceeded the USEPA Eco-SSL for that metal, its potential for risk was found to be negligible based on the 95% UCL concentration for the 2-12 in. soil depth interval and a refinement of the ecological soil screening level based on less conservative exposure assumptions for the 0-2 in. depth interval. Therefore, it can be concluded that none of the MCs evaluated pose a potential for risk to ecological receptors at Former South Beach Moving Target Machine Gun and Katama Rocket Range MRS.



Anomaly Type

- MEC
- MD
- Non-MD
- Cultural Artifact
- No Find
- Seed
- Former Rocket Target
- Ocean Transect Inaccessible*
- Geophysical Survey Transect
- Ocean Transect with MD
- Ocean Transect with no MEC, MPPEH, or MD
- Intrusive Grid
- South Beach Investigation Area
- S0001 Intrusive Grid ID

US Army Corps of Engineers

FIGURE 2-4

Nature and Extent of MEC Identified During RI - Former South Beach Moving Target Machine Gun and Katama Rocket Range MRS, Martha's Vineyard, MA, Martha's Vineyard, MA

0 200 400 800 1,200 1,600 Meters

0 750 1,500 3,000 4,500 Feet

UXB amec

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

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2.3.5 Munitions Response Site Prioritization Plan

The Munitions Response Site Prioritization Protocol (MRSPP) ranking was revised during the RI to assign a relative risk for the individual MRSs. This ranking system uses scores of 1 through 8, 1 indicating the highest potential priority and 8 indicating the lowest potential priority, to determine a relative priority for response activities. The priorities do not have specific assigned actions. Ultimately, the MRS Priority is used to determine the future funding sequence of MRSs for further munitions response action.

The Former South Beach Moving Target Machine Gun and Katama Rocket Range MRS received a MRSPP priority or rating of 6. The MRSPP score for the Remaining Ocean MRS received a priority or rating of no known of suspected hazard.

2.3.6 Munitions and Explosives of Concern Hazard Assessment

In October 2008, the Technical Working Group for Hazard Assessment, which included representatives from the DoD, Department of the Interior, EPA, and other officials, made available the technical reference document, *Interim Munitions and Explosives of Concern Hazard Assessment (MEC HA) Methodology* (EPA, 2008). This document is designed to be used as the CERCLA hazard assessment methodology for MRSs where there is an explosive hazard from the known or suspected presence of MEC. Although the potential exists for an explosive hazard, no UXO or DMM were identified during the RI field activities. Since no MEC was found a MEC HA score was not able to be determined for the MRS (UXB, 2014).

2.3.7 Environmental Setting

2.3.7.1 Climate

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 in 1948, and the lowest temperature ever was -9 degrees Fahrenheit in 1961 (USACE, 2009).

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 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, 2009).

2.3.7.2 Geology

The MRA 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, 2009).

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, 2009). 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. The bedrock consists of metamorphic rocks, such as schist and gneiss, and igneous rocks (USACE, 2009).

2.3.7.3 Topography

The inland portion of the site is relatively flat at South Beach and slowly rises to the east toward the bluff at Wasque Point. Elevations within the MRS range from 0 ft above mean sea level (msl) along the shore to approximately 32 ft above msl at Wasque Point. Due to the dynamic nature of the beach portion of the site, the landscape of the beach is continuously changing.

2.3.7.4 Soils

Soils underlying the MRA consist of beach areas and Udipsamments soils, which are found near the coast. Both soils consist of deep sand of various textures that have rapid to very rapid permeability. Due to the continuous washing and rewashing by waves, beach areas typically do not have plant cover. Most areas of Udipsamments will have a cover of grasses and shrubs. The beaches nearest the ocean are inundated twice daily by tides. The entire beach is generally flooded by spring tides and storm tides (United States Department of Agriculture – Soil Conservation Service [USDA-SCS], 1986).

Carver loamy coarse sand and Katama sandy loam soils are located on the remaining portion of the site. These soils are very deep and range from well to excessively drained. These soils typically consist of sandy loam and loamy coarse sand over coarse sand. The permeability of these soils ranges from moderately rapid to very rapid. Depth to seasonal high water table is greater than 6 ft below ground surface (bgs) in both soils (USDA-SCS, 1986).

2.3.7.5 Surface Water Hydrology

Soils in the upland areas and on the beaches are excessively drained and have very high permeability (USDA-SCS). Therefore, there is very little to no surface water runoff in these areas.

Mattakeset Herring Creek flows through the south-central portion of the site between two former firing lines and the former moving target track (Figure 2-2). This stream flows from Crackatuxet Cove southeast into Mattakeset Bay. A visual survey of the "creek" identified the drainage as a concrete culvert that is ephemeral in nature and was not sampled during the RI.

2.3.7.6 Groundwater Hydrology

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 to be part of the aquifers of Martha's Vineyard (USACE, 2009).

The water table at South Beach generally mimics topography and is weakly 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 to 6 ft bgs in upland soils to near ground surface in lower areas near shorelines and marshes (USACE, 2009). The shallow freshwater aquifer is underlain by brackish water that is unsuitable for human consumption (USACE, 2008). In general, supplies of water for homes, cooling, and small businesses can be developed in most areas of outwash from wells that are 1.5 to 2 in. in diameter with 3 ft of screen set about 10 ft below the water table.

2.3.7.7 Sensitive Species, Environments, and Environmental Resources

The current MRA includes three habitat types: 1) upland habitat; 2) beach; and 3) ocean. These areas provide habitat to a variety of terrestrial plants, invertebrates, and wildlife as well as marine organisms. The MRA has been designated as a Priority Habitat of Rare Species and Estimated Habitats of Rare Wildlife in the Massachusetts 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 MRA 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 2-2). Table 2-2 is specific to Martha's Vineyard. Table 2-3 summarizes the observed species found within the MRA. 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 South Beach, they are likely to occur in the offshore MRS only briefly as transients. State listed species include many insect and plant species which may utilize upland coastal sandplain or beach habitat. During the RI, the project entomologist determined no known colonies of northeastern tiger beetle exist at this MRS.

2.2.3.3.0.2 The RI field work schedule was developed to avoid nesting seasons/fledgling seasons (spring/summer) as much as possible. During the RI fieldwork conducted from December 2010 to November 2011, the field crew coordinated on a daily basis with the TTOR who was monitoring daily bird activity on South Beach to ensure the RI work was not interfering or encroaching on the protected birds' species. On only one occasion did the UXO field crew observe two nesting piping plovers on the eastern end of South Beach. Massachusetts Natural Heritage and Endangered Species Program (MNHESP) was notified of the siting, however, they were not within the designated work area. No other threatened or endangered species were observed within the MRA.

Table 2-2. Endangered, Threatened, and Special Concern Species
South Beach Munitions Response Area

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			
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 1 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	--
Comet Darner	*Anax longippes*	Special Concern	--
Purple Tiger Beetle	*Cicindela purpurea*	Endangered	--
Northeastern Tiger Beetle	*Cicindela dorsalis*	Endangered	Threatened
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).
-- Status not listed

Table 2-3. Observed Species within South Beach MRA

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	5 pairs of piping plovers nested at Norton Point Beach in Edgartown, 2010 TTOR data observed Piping Plovers at Norton Point	Final TCRA After Action Report (March 2010)
Common Tern (*Sterna hirundo*)	No	Yes	Yes	Yes	2010 nesting data provided by TTOR - Least and Common Tern nesting was recorded at Norton Point Beach	Chapter 7.0 Environmental Protection Plan, Final RI Work Plan (November 2010)
Least Tern (*Sterna antillarum*)	No	Yes	Yes	Yes		

2.3.7.8 Demographics

The MRA is located in 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 1,788 houses are occupied by year-round residents, 3,258 are seasonal or occasional use, and the remaining 168 houses are unoccupied. The population density in this area is 151 persons per square mile (US Census Bureau, 2012).

2.3.7.9 Current and Future Land Use

Currently, the MRA is owned by Dukes County, Massachusetts Department of Conservation and Recreation (MADCR), private landowners, The Trustees of Reservations (TTOR), and the Commonwealth of Massachusetts (some beach property as well as inland and coastal waters). Figure 2-6 illustrates which property tracks are owned by public entities and which tracts are privately owned within the MRA. South Beach is managed by the Edgartown Parks and Recreation Department from May through Labor Day of each year. The former range encompasses an area that is currently a popular public beach used for recreational purposes such as hiking, canoeing, kayaking, recreational fishing, clamming, crabbing, wildlife observation, photography, education, and other water-related activities. Land use is not expected to change in the future; however, it is possible that additional upland and beach habitat may be lost due to erosion (UXB, 2011).

2.3.7.10 Remedial Investigation Conclusions

The objective of the RI, to delineate the nature and extent of MEC and MCs impacted from historic training activities conducted at the South Beach MRA, was achieved. RI activities including geophysical surveying, intrusive investigations, and environmental sampling for analysis of MCs was conducted within land, beach, and ocean sub-areas.

Key findings of the RI include:

- During the RI, 97 MD items and 98 non-MD items were identified. No MEC items were identified during the field investigation.
- At the Former Moving Target Machine Gun Range:
    - A 300m firing line was confirmed through visual inspection of a concrete pad with stanchions for mounting machine guns.
    - The 150m firing line and suspected firing line and impact berm were not confirmed through visual inspection. The areas are residential and have been disturbed by building and landscaping activities.

  - MEC was not identified during the RI at the Former Moving Target Machine Gun Range.

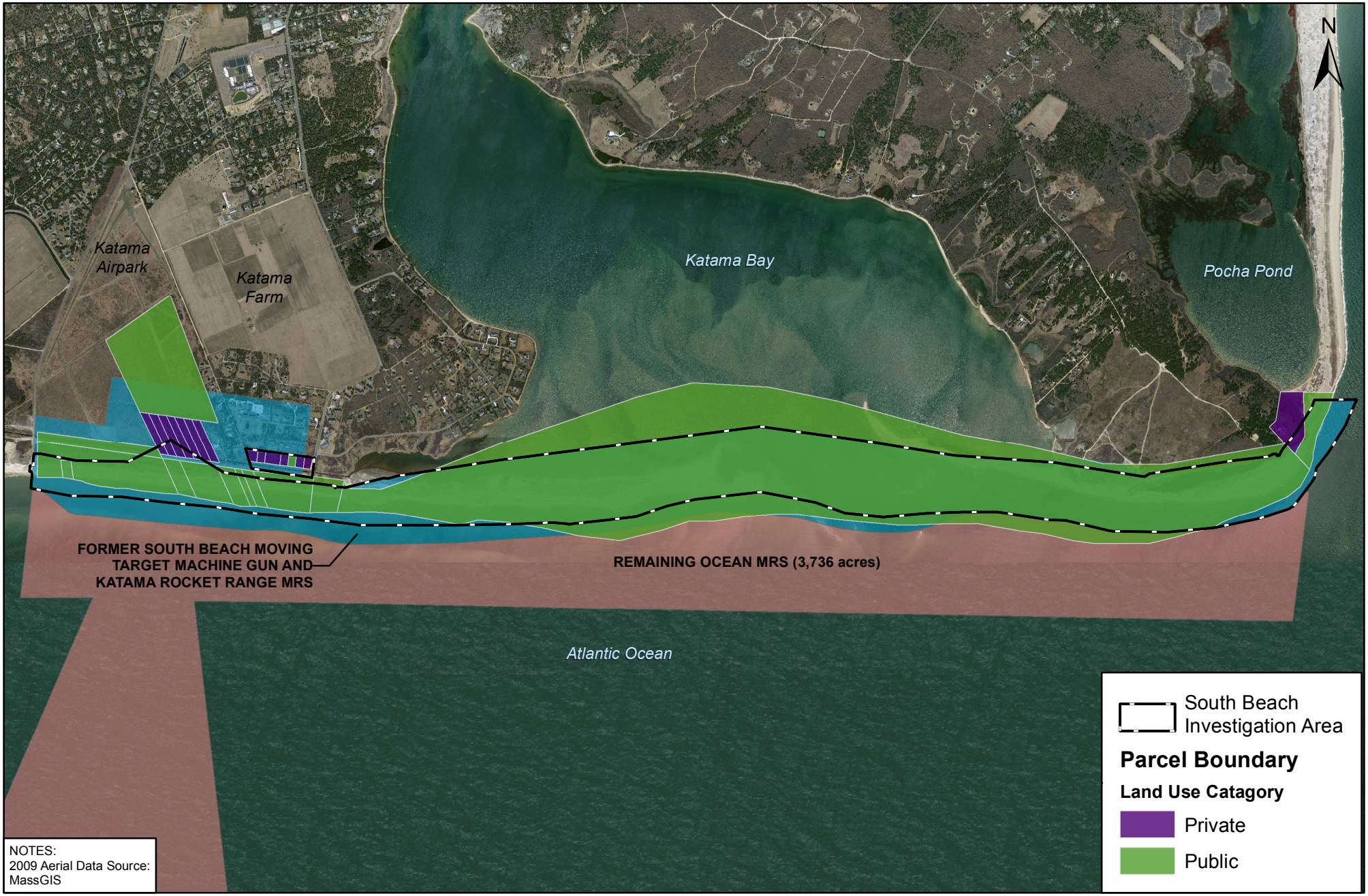
- At the Former Katama Rocket Range:
  - While the former target areas are currently underwater, the limits of the rocket training range and the distribution of munitions debris have been confirmed through geophysics and intrusive investigation.
  - MEC was not identified during the RI at the former Katama Rocket Range. MD has been identified in ocean, land, and beach areas.
  - A transport study conducted in the vicinity of the historic rocket targets demonstrates that ferrous items are moving into these two grid areas, with a measurable change after storm events.
  - Due to significant beach erosion and deeper water depths in the surf zone, ferrous items including rocks with ferrous signatures previously buried below sensor detection depth may have become detectable/ exposed and migrated into the previously cleared grids; all items were within 400 feet of the water's edge as measured from the mean low-tide mark.
  - The distribution of MD concentrations is further east of the former target areas indicating a strong prevailing easterly ocean current; this is further confirmed by the acoustic pinger which broke free from one of the seed items in the transport study which washed ashore approximately one mile east of where it was emplaced.
  - MEC was not identified during the RI at the Former Katama Rocket Range.
- During emergency responses, two 100 pound bombs were reported at two instances (one in 2008 and one in 2009) at Wasque point, approximately 2.1 miles from where the majority of MD was identified. No additional MEC or MD was identified during the RI at Wasque Point. There is no supporting evidence through historical research or the RI that they were part of historical military operations conducted at South Beach and are considered isolated finds unrelated to the site.
- MC sampling indicated that human health screening criterion were not exceeded in soil or groundwater.
- No high explosive compounds or their by-products were detected in soil; therefore, none of these compounds pose a potential risk to ecological receptors resources at this site.
- A HHRA was performed during the RI. None of the key metals (antimony, copper, lead, nickel, and zinc) were detected in soil at levels that exceed MADEP-specified background concentrations; therefore, all are consistent with a condition of No Significant Risk based on the MCP Method I Standards.

- A SLERA for MCs was performed during the RI. Although concentrations of lead in surface soil exceeded the USEPA Eco-SSL for that metal, its potential for risk was found to be negligible based on the 95% UCL concentration for the 2-12 in. soil depth interval and a refinement of the ecological soil screening level based on less conservative exposure assumptions for the 0-2 in. depth interval. Therefore, it can be concluded that none of the MCs evaluated at the MRA pose a potential for risk to ecological receptors.

Based upon the RI results, the following recommendations were proposed.

- Revise the current MRA Boundary to include the extent of MEC and MD determined through previous investigation, geophysical and intrusive investigation data.
- The South Beach MRA should be subdivided into two MRSs, comprising the Former Machine Gun Range and Katama Rocket Range (695 acres) and the Remaining Ocean Area (3,736 acres).

Although no MEC was identified at the MRA, a FS was recommended to evaluate future response action alternatives with regard to potential MEC hazards at the South Beach MRA. Due to the significant density of MD discovered and estimated to remain within the Former Machine Gun Range and Katama Rocket Range MRS boundary, coupled with likely public exposure to the practice rockets, and small potential of MEC on the site, as well as the need to employ UXO-certified technicians to make the determination whether a munition is inert or UXO, pursuing an FS is warranted. No further evaluation of MC is warranted.



US Army Corps of Engineers

UXB amec

FIGURE 2-5

Current Land Use - Former South Beach Moving Target Machine Gun and Katama Rocket Range MRS, Martha's Vineyard, MA

0 1,100 2,200 3,300 4,400 5,500 Feet	0 250 500 750 1,000 Meters	04/13/2015	Rev:	Drawn: JBO	Chk: DMS	SBeach_Private_Public_Land_FS.mxd	PROJ: 562910000

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3.0 Applicable or Relevant and Appropriate Requirements and To Be Considered Criteria

Pursuant to 40 Code of Federal Regulations (CFR) Part 300.400(g) of the NCP, a list of ARARs and other TBC information has been developed for a site or sites to identify the requirements that may apply to a removal or remedial action. CERCLA Section 121 (d)(2)(A) requires that remedial actions meet any federal standards, requirements, criteria, or limitations that are determined to be legally applicable or relevant and appropriate. CERCLA Section 121 (d)(2)(A)(ii) requires state ARARs to be met if they are more stringent than federal requirements and are proposed by the state. In addition, the NCP, published in 40 CFR Part 300.400(g)(3), states that TBC criteria may be listed. TBC are local ordinances, unpromulgated criteria, advisories, or guidance that do not meet the definition of ARARs but that may assist in the development of remedial objectives.

ARARs are defined as follows:

- Applicable requirements - Those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site. Only those state standards that are identified by a state in a timely manner and that are more stringent than federal requirements may be applicable.

- Relevant and appropriate requirements - Those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site. Only those state standards that are identified by a state in a timely manner and that are more stringent than federal requirements may be relevant and appropriate.

There are three types of ARARs:

- Chemical-specific requirements, which define acceptable exposure concentrations or water quality standards.

- Location-specific requirements, which may restrict remediation activities at sensitive or hazard-prone locations such as active fault zones, wildlife habitats, and floodplains.

- Action-specific requirements, which may control activities and technology.

It is first determined whether an ARAR is applicable for the site. If it is not applicable, then it is determined whether the ARAR is relevant and appropriate. The procedure for determining whether a requirement is relevant and appropriate is a two-step process. First, to determine relevance, it is evaluated whether the requirement addresses problems or situations sufficiently similar to the circumstances of the proposed response action. Second, for appropriateness, the determination must be made about whether the requirement would also be well-suited to the conditions of the site. In some cases, only a portion of a requirement would be both relevant and appropriate. If a requirement is not both relevant and appropriate, it is not an ARAR.

"Applicable requirements" and "relevant and appropriate requirements" are considered to have the same weight under CERCLA. Once a requirement is determined to be "applicable" or "relevant and appropriate", during the remedy selection process, the remedial action must attain the identified ARARs or provide grounds for invoking a waiver as described in the NCP [40 CFR 300.430(f)(1)(ii)(C)]. Section 121(d) of CERCLA requires attainment of federal ARARs and of state ARARs in state environmental or facility siting laws where the state requirements are promulgated, more stringent than federal laws, and identified by the state in a timely manner.

CERCLA and the NCP also recognize the TBC category, which includes non-promulgated federal and state criteria, strategies, advisories, and guidance documents. The TBC information do not have the same status as ARARs; but, if no ARAR exists for a substance or particular situation, TBCs may be used to ensure that a remedy is protective.

ARARs identified during the remedial investigation are evaluated and potentially eliminated during the FS and finalized prior to issuance of the Decision Document (DD) For a remedial alternatives to pass into the detailed analysis stage of the FS and thus become eligible for selection, it must comply with its ARARs or a waiver should be identified and the justification provided for invoking it. An alternative that cannot comply with ARARs, or for which a waiver cannot be justified, should be eliminated from consideration for further discussion as a potential alternative. Updates to ARARs are made as details of remedial alternatives become known. Thus, potential ARARs that are initially identified on a fairly broad basis, are refined to specific requirements during the subsequent stages of the remedial process, and are finalized upon signature of the DD.

Twenty Five potential ARARs for the Former South Beach Moving Target Machine Gun and Katama Rocket Range MRS are being carried forward to this FS. No TBC criteria were identified. Primary consideration will be given to remedial alternatives that attain or exceed the requirements of its ARARs. ARARs will be evaluated for each alternative in Section 6.0, Detailed Analysis.

The following requirements have been identified as potential ARARs. Only the substantive portions of these provisions are applicable or relevant and appropriate. Permits, consultations and plans are not included:

40 CFR 264.601 establishes requirements under RCRA 40 CFR 264 subpart X applicable to operators of open burning or open detonation of explosive waste, including military munitions and explosive wastes. Specifically, 40 CFR 264.601 requires that miscellaneous units be located, designed, constructed, operated, maintained, monitored and closed in a manner that will ensure protection of human health and the environment. Only substantive portions are appropriate for any future remedial alternatives that address MEC disposal using technologies or disposal means classified as "miscellaneous units" under Subpart X, including consolidated detonation areas.

16 U.S.C. §1538(a)(1)(B) with respect to any endangered species of fish or wildlife listed pursuant to Section 1538 of Title 16 (Conservation), it is unlawful for any person subject to the jurisdiction of the U.S. to take any such species within the U.S. or the territorial sea of the U.S. Appropriate for any future response actions that may impact listed species.

321 CMR *10.04(1)* ***Prohibitions. …, no person may take, possess, transport, export, process, sell or offer for sale, buy or offer to buy, nor shall a common or contract carrier knowingly transport or receive for shipment, any plant or animal or part thereof on the state list or federal list; provided, however, that ownership, sale, or purchase of real property on which such plant or animal occurs is not prohibited.***

Several requirements, though not ARAR in themselves, are important to understanding the extent and breadth of 10.04(1) under Massachusetts law and must be adhered to as these are mandatory provisions. These include 321 CMR 10.16(1), 10.17(1) and 10.90.

a. 10.16(1) ***Project Segmentation. Projects shall not be segmented or phased to evade or defer the review requirements of 321 CMR 10.13 and 10.18 through 10.23 or the eligibility requirements for an exemption under 321 CMR 10.14. For the purposes of 321 CMR 10.13, 10.14 and 10.18 through 10.23, the entirety of a proposed Project subject to review, including likely future expansions, shall be considered, and not separate phases or segments thereof. In determining whether two or more segments or components are in fact parts of one Project, all circumstances shall be considered, including but not limited to time interval between phases, whether the segments or components, taken together, constitute a part of a common plan or scheme, whether there is a commonality of ownership interests across two or more separate legal entities, whether and whether environmental impacts are separable. Ownership by different entities does not necessarily indicate that two segments or components are separate. …***

b. 10.17(1) ***Whether a Project or an Activity is within or encroaches upon a Priority Habitat shall be determined by consulting the Natural Heritage Atlas, which shall be the authoritative delineation of the boundaries of said Priority Habitat.***

c. 10.23 (see discussion below)

d. 10.90 (1) ***Introduction. The list in 321 CMR 10.90 contains the names of all species of plants and animals which have been determined to be Endangered, Threatened, or of Special Concern pursuant to M.G.L. c. 131A and 321 CMR 10.03.***

The substantive provisions of 321 CMR 10.23 as included below are adopted as ARAR in themselves (and also as an inherent exception to the prohibition in 321 CMR 10.04(1)). Since only the substantive portions of this provision are applicable or relevant and appropriate, permits, consultations, and plans are not included. As such, where it says "permit" in Section (1) and (7),below, that should be read to mean "allow." In Section (2)(c) and (3), below, "plan" means "actions." In Section (2) the following phrase "Director may issue a conservation and management permit" is understood to mean "the taking is allowed." Further, throughout 321 CMR 10.23 "Applicant" is recognized as the USACE.

(1) … permit the Taking of a State-listed Species for conservation or management purposes provided there is a long-term Net Benefit to the conservation of the impacted species. …

(2) Except as provided in 321 CMR 10.23(6) below, if … the applicant … has avoided, minimized and mitigated impacts to State-listed Species consistent with the following performance standards, … the Director may issue a conservation and management permit provided:

(a) The applicant has adequately assessed alternatives to both temporary and permanent impacts to State-listed Species;

(b) An insignificant portion of the local population would be impacted by the Project or Activity, and;

(c) The applicant agrees to carry out … conservation and management plan … that provides a long-term Net Benefit to the conservation of the State-listed Species … and shall be carried out by the applicant.

(3) Except as provided in 321 CMR 10.23(6) below, if a conservation and management … applicant is unable to demonstrate the long-term Net Benefit performance standard on the project site and the applicant has made every reasonable effort to avoid, minimize and mitigate impacts to the State-listed Species on site, then the conservation and management plan … meet the long-term Net Benefit performance standard by providing for financial or in-kind contributions toward the development and/or the implementation of an off-site conservation recovery and protection plan for the impacted species.

(4) …

(5) …

(6) Projects or Activities Eligible for Coverage … when the Division has issued a Conservation Plan

(a) …

(b) …

1. The applicant shall implement and comply with species-specific development standards or best management practices, or both, applicable to the geographic area and the species habitat that would be impacted by the Project or Activity. Notwithstanding 321 CMR 10.23(2), the proponent is not required to provide an alternatives analysis or to demonstrate that an insignificant portion of the local population of the affected State-listed Species of Special Concern would be impacted by the Project or Activity.

2. The applicant shall provide off-site mitigation, or a combination of on-site and off-site mitigation subject to the Division's approval, that achieves the long-term Net Benefit standard in 321 CMR 10.23(1), as determined by the Division. Any off-site mitigation provided by the applicant in the form of a financial contribution will be used to fund habitat management or the protection of land or other appropriate mitigation within one or more conservation protection zones established in the conservation plan issued by the Division pursuant to 321 CMR 10.26. The amount of any such off-site mitigation payment will be determined by the Division based on a formula set forth in written guidance that, at a minimum, considers the area of impact on the on-site habitat of the affected State-listed Species of Special Concern and the land values within one or more of the conservation protection zones. Notwithstanding 321 CMR 10.23(3), the applicant may propose off-site mitigation without a showing that the applicant has made every reasonable effort to avoid, minimize and mitigate impacts to the affected State-listed Species of Special Concern on-site.

3. …

(c) …

(7) General Mitigation Standards applicable to Individual and General Conservation and Management Permits issued by the Director.

(a) … generally apply the following areal habitat mitigation ratios, based on the category of State-listed Species:

1. Endangered Species: 1:3 (i.e., protection of three times the amount of areal habitat of the affected Endangered Species that is impacted by the Project or Activity);

2. Threatened Species: 1:2 (i.e., protection of two times the amount of areal habitat of the affected Threatened Species that is impacted by the Project or Activity).

3. Special Concern Species: 1:1.5 (i.e., protection of one and one half times the amount of areal habitat of the affected Species of Special Concern that is impacted by the Project or Activity).

(b) … A project proponent may also request in writing that the Director apply an alternative mitigation ratio or alternative mitigation approach to the Project or Activity. Any such request shall explain why an alternative mitigation ratio or alternative mitigation approach is appropriate, addressing the relevant factors in 321 CMR 10.23(7)(b)1.-5. below. In determining whether an alternative mitigation ratio or alternative mitigation approach is appropriate, the Director will consider factors that include but are not limited to:

1. the size and configuration of the habitat impact;

2. the threats to the affected State-listed Species posed by uses or activities located adjacent or in close proximity to the Project or Activity that is the subject of the conservation and management permit;

3. the size, configuration and quality of the habitat proposed to be protected by the applicant;
4. the population density of the affected State-listed Species; and

5. the habitat management and research needs associated with the affected State-listed Species.
(c) …

310 CMR 9.40 (2)(b) (1st sentence) – Though this project does not constitute dredging and, therefore, this requirement is not applicable, this provision was deemed relevant and appropriate.

The design and timing of dredging and dredged material disposal activity shall be such as to minimize adverse impacts on shellfish beds, fishery resource areas, and submerged aquatic vegetation.

310 CMR 9.40 (3)(b) (1st sentence) – Though this project does not constitute dredging and, therefore, this requirement is not applicable, this provision was deemed relevant and appropriate based on state representations that this provision is not limiting the scope of the remediation, but rather requires the use of best management practices to minimize "slumping."

The shoreward extent of dredging shall be a sufficient distance from the edge of adjacent marshes to avoid slumping.

310 CMR 10.25 (5) Land under the Ocean

Projects … which affect nearshore areas of land under the ocean shall not cause adverse effects by altering the bottom topography so as to increase storm damage or erosion of coastal beaches, coastal banks, coastal dunes, or salt marshes.

310 CMR 10.25 (6) Land under the Ocean

Projects … which affect land under the ocean shall if water-dependent be designed and constructed, using best available measures, so as to minimize adverse effects, …

310 CMR 10.25 (7) Land under the Ocean

Notwithstanding the provisions of 310 CMR 10.25(3) through (6), no project may … have any adverse effect on specified habitat sites of rare vertebrate or invertebrate species, as identified by procedures established under 310 CMR 10.37.

310 CMR 10.27 (3) Coastal Beaches

Any project on a coastal beach shall not have an adverse effect by increasing erosion, decreasing the volume or changing the form of any such coastal beach or an adjacent or downdrift coastal beach.

310 CMR 10.27 (6) Coastal Beaches

In addition to complying with the requirements of 310 CMR 10.27(3) and (4), a project on

a tidal flat shall if water-dependent be designed and constructed, using best available measures, so as to minimize adverse effects, …

310 CMR 10.27 (7) Coastal Beaches

Notwithstanding the provisions of 310 CMR 10.27(3) through (6), no project may … have any adverse effect on specified habitat sites of rare vertebrate or invertebrate species, as identified by procedures established under 310 CMR 10.37.

310 CMR 10.28 (3) Coastal Dunes

Any alteration of, or structure on, a coastal dune or within 100 feet of a coastal dune shall not have an adverse effect on the coastal dune by:

(a) affecting the ability of waves to remove sand from the dune;

(b) disturbing the vegetative cover so as to destabilize the dune;

(c) causing any modification of the dune form that would increase the potential for storm or flood damage;

(d) interfering with the landward or lateral movement of the dune;

(e) causing removal of sand from the dune artificially; or

(f) interfering with mapped or otherwise identified bird nesting habitat

310 CMR 10.28 (6) Coastal Dunes

Notwithstanding the provisions of 310 CMR 10.28(3) through (5), no project may … have any adverse effect on specified habitat sites of Rare Species, as identified by procedures established under 310 CMR 10.37.

310 CMR 10.29 Barrier Beaches – Though this provision does not meet the definition of an ARAR, we are on notice that the other ARAR requirements found in 310 CMR 10 also apply to barrier beaches.

310 CMR 10.32 (3) Salt Marshes

A proposed project in a salt marsh, on lands within 100 feet of a salt marsh, or in a body of water adjacent to a salt marsh shall not destroy any portion of the salt marsh and shall not have an adverse effect on the productivity of the salt marsh. Alterations in growth, distribution and composition of salt marsh vegetation shall be considered in evaluating adverse effects on productivity. …

310 CMR 10.32 (6) Salt Marshes

Notwithstanding the provisions of 310 CMR 10.32(3) through (5), no project may … have any adverse effect on specified habitat sites of Rare Species, as identified by procedures established under 310 CMR 10.37.

314 CMR 9.06 (2)(1st sentence) Though this project does not constitute dredging and, therefore, this requirement is not applicable, this provision was deemed relevant and appropriate.

No discharge of dredged or fill material [in waters of the United States within the Commonwealth can occur] … unless appropriate and practicable steps have been taken which will avoid and minimize potential adverse impacts to the bordering or isolated vegetated wetlands, land under water or ocean, or the intertidal zone.

314 CMR 9.07 (1)(a)(1st sentence) Though this project does not constitute dredging and, therefore, this requirement is not applicable, this provision was deemed relevant and appropriate.

No dredging shall … occur unless appropriate and practicable steps have been taken which will first avoid, and if avoidance is not possible then minimize, or if neither avoidance or minimization are possible, then mitigate, potential adverse impacts to land under water or ocean, intertidal zone and special aquatic sites.

4.0 Identification and Screening of Technologies

This section establishes the RAO for the FS and identifies general response actions and potential MEC detection and removal technologies for the Former South Beach Moving Target Machine Gun and Katama Rocket Range MRS. An initial screening is performed for effectiveness, implementability, and cost to evaluate viability for use at the MRS. The general response actions and viable technologies identified in this section are assembled into process options that can achieve the RAO in the Development and Screening of Alternatives (Section 5) and are further evaluated in the Detailed Analysis of Alternatives (Section 6) of this report.

4.1 Remedial Action Objectives

The NCP CFR 300.430(e)(2)(i) specifies that RAOs be developed to address: (1) contaminants of concern, (2) media of concern, (3) potential exposure pathways, and (4) preliminary remediation goals. RAOs are: defined to determine the effectiveness of the remedial actions; developed for MEC based on the MRS requirements and exposure pathways; and, focused on limiting or removing exposure pathways for MEC (US Army Environmental Command, 2009). The RAO for the Former South Beach Moving Target Machine Gun and Katama Rocket Range MRS addresses the overall goal of managing risk and protecting human health based on the results of the RI.

The RI included a finding that there was a low statistical potential for MEC to be present and therefore a MEC source or explosive hazard is possible, in the MRS. The significant amount of MD within the MRS and the high volume of receptors indicates that munitions will continue to be encountered at this site in the future. The MD (intact practice rockets and associated components) was confirmed within the MRS at ground surface and in ocean subsurface to varying depths due to cyclic erosion and building of the beach in the surf zone.

Due to munitions estimated to remain within the ocean and beach at the Former South Beach Moving Target Machine Gun and Katama Rocket Range MRS, recreational users, Edgartown Parks and Recreation personnel, contractor/maintenance workers, visitors/trespassers, MADCR personnel, and TTOR personnel may encounter munitions while engaging in surface and intrusive activities. Therefore, the RAO for the Former South Beach Moving Target Machine Gun and Katama Rocket Range MRS is:

> *To reduce the probability of the public from handling munitions encountered during residential, construction/maintenance, and recreational activities performed at ground surface, in subsurface soil to 4 feet below ground surface, and in the area of breaking waves, or the ocean surf zone.*

4.2 General Response Actions

General response actions are those actions that support the development of remedial alternatives that will achieve the RAO. The following general response actions are considered for the Former South Beach Moving Target Machine Gun and Katama Rocket Range MRS:

- Risk Management - Risk Management, which is considered a "limited" action alternative by EPA, includes various land use control(s) (LUC) options that rely on legal mechanisms, engineering controls, or administrative functions to control access or modify human behavior and provide long-term management (LTM) of risk.
- Removal Action – Remaining munitions can be detected and removed from the ground surface and/or below the ground surface. Alternatives for munitions clearance include technologies for detection, positioning for the detection technologies, removal, and disposal.

4.3 Evaluation of Technologies

Various technologies and approaches exist to manage risks associated with MEC. Risk management can be accomplished through a variety of engineering or LUC components (i.e., institutional controls [ICs]) designed for implementation based on MRS-specific conditions. Clearance activities include three steps: detection, removal, and disposal. A description of the technologies used in each step is presented in the following subsections. At the end of each subsection, the technologies are screened against the three screening criteria to determine their viability for use at the Former South Beach Moving Target Machine Gun and Katama Rocket Range MRS.

4.3.1 Screening Criteria

Potential remedial technologies are first evaluated against the three general categories of effectiveness, implementability, and cost described below. The purpose of this initial screening is to ensure that the technologies meet the minimum standards of the criteria within each category in the FS process and can be used to assemble viable remedial alternatives to achieve the RAO. The three general categories are described in the following sections.

4.3.1.1 Effectiveness

In accordance with EPA guidance (EPA, 1988), technologies or alternatives that have been identified should be evaluated further based on their effectiveness relative to other processes within the same technology or alternative type. This evaluation should focus on: (1) the potential effectiveness of technology or alternative options in handling the estimated areas or volumes of

media and meeting the RAO; (2) the potential impacts to human health and the environment during the removal or implementation phase; and, (3) how proven and reliable the technology or alternative is with respect to the MEC and conditions at the site.

4.3.1.2 Implementability

Implementability, as a measure of both the technical and administrative feasibility of constructing, operating, and maintaining a remedial action alternative, is used during screening to evaluate the combinations of technology or alternative options with respect to conditions at a specific site. Technical feasibility refers to the ability to construct and reliably operate, a technology or alternative option until a remedial action is complete. It also includes operation, maintenance, replacement, and monitoring of technical components of a technology or alternative, if required, into the future after the remedial action is complete. Administrative feasibility refers to the ability to obtain approvals from other offices and agencies; the availability of treatment, storage, and disposal services and capacity; and the requirements for, and availability of, specific equipment and technical specialists (EPA, 1988).

The determination that a technology or alternative is not technically feasible will usually preclude it from further consideration unless steps can be taken to change the conditions responsible for the determination. Typically, this type of "fatal flaw" will be identified during technology screening, and an alternative consisting of an infeasible technology will not be retained. Negative factors affecting administrative feasibility will normally involve coordination steps to lessen the negative aspects of the technology or alternative but will not necessarily eliminate a technology or alternative from consideration (EPA, 1988).

4.3.1.3 Cost

Typically, technologies and alternatives are defined sufficiently prior to screening so that estimates of cost are available for developing comparisons among technologies and alternatives. However, because uncertainties associated with the definition of technologies and alternatives often remain, it may not be practicable to define the costs of technologies and alternatives with the accuracy desired for the detailed analysis [(i.e., +50% to -30%) (EPA, 1988)].

According to EPA guidance, a high level of accuracy in cost estimates during screening is not required. The focus should be to make comparative estimates for technologies and alternatives with relative accuracy so that cost decisions among technologies and alternatives will be sustained as the accuracy of cost estimates improves beyond the screening process (EPA, 1988).

4.3.2 Land Use Controls

In accordance with the FUDS program guidance, the term LUCs encompasses physical, legal, or administrative mechanisms that restrict the use of, or limit access to, contaminated property to reduce risk to human health and the environment. Physical mechanisms encompass a variety of engineered remedies to contain or reduce contamination and physical barriers to limit access to property, such as fences or signs. The legal mechanisms are generally the same as those used for ICs as discussed in the NCP. ICs are a subset of LUCs and are primarily legal mechanisms imposed to ensure the continued effectiveness of land use restrictions imposed as part of a remedial decision. Legal mechanisms include restrictive covenants, negative easements, equitable servitudes, and deed notices. Administrative mechanisms, which can also be ICs, include notices, adopted local land use plans and ordinances, educational programs, construction permitting, or other existing land use management systems that may be used to ensure compliance with use restrictions (USACE, 2004). Educational programs can include a variety of types of information dissemination and training that can be tailored to specifically address an identified hazard and exposed populations.

Development of LUC components considered for the MRS referred to the USACE guidance Engineering Pamphlet (EP) 1110-1-24 for Establishing and Maintaining Institutional Controls for Ordnance and Explosive (OE) Projects (USACE, 2000). The main objective is to design controls that rely on legal mechanisms, physical barriers or warnings, or administrative mechanisms such as construction support or educational components to restrict access or modify human behavior to reduce exposure risks. LUCs should be managed and maintained at the local level whenever possible. For most FUDS properties, the federal government does not own the property. Therefore, property owners or state and local government agencies with appropriate authorities (i.e., zoning boards) are often the best candidates for LUC management and enforcement on FUDS properties (USACE, 2004).

Effectiveness of LUCs is dependent on coordination and willingness to participate in maintenance and enforcement by all stakeholders for the duration that the specific control applies to the MRS. When LUCs are established, the ability to perform periodic inspections and measure effectiveness is critical to attaining remedial objectives. Land use controls to guide human behavior and manage risk are described and screened against the three criteria of effectiveness, implementability, and cost for use at the Former South Beach Moving Target Machine Gun and Katama Rocket Range MRS in Table 4-1.

To facilitate development and evaluation of LUC options and viability for use at the Former South Beach Moving Target Machine Gun and Katama Rocket Range MRS, an Institutional Analysis was performed for the MRS to support the FS and is provided as Appendix B.

4.3.3 MEC Detection

Detection technologies include those methods and instruments used to locate surface and subsurface MEC for clearance, which are the same as those used for MEC as the properties of the munitions are the same that would be detected. The best detection method is selected based on the MEC properties such as the depth and size of the suspected items, and the physical characteristics of the Former South Beach Moving Target Machine Gun and Katama Rocket Range MRS (i.e., soil type, topography, vegetation, and local geology, sediment littoral characteristics and underwater topography).

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Table 4-1. Land Use Controls

Technology	Effectiveness	Implementability	Cost	Representative Systems	Notes	Viability at MRS/Status of Retention
Legal Mechanisms: Institutional controls such as governmental controls	**High**: When imposed and enforced, legal restrictions can effectively limit or prevent exposure risks to a known hazard and can be evaluated for effectiveness via periodic inspection.	**Very Difficult**: Because any legal mechanisms would need to be established by the property owners (non-DoD entities); to implement this type of control the Army can only assist in a coordination capacity with the landowner to guide implementation in an effective manner.	**Low**: Costs are variable based on level of effort.	Administrative	The MRS is a non-DoD property managed under FUDS without the ability for the Army to impose legal restrictions. Any legal mechanisms would need to be established by the property owners.	**Low/Not Retained:** Because the MRS is a FUDS, the Army cannot impose legal restrictions on the non-DoD land included within the MRS boundaries.
Physical Mechanisms: Engineered barriers or physical structures designed to prevent access such as fencing or guard posts. Physical mechanisms also include the installation or construction of signs designed to provide information on the potential hazards at a site.	**Low**: Fencing or guards to restrict access is not anticipated to be very effective at the MRS as the delineated MEC is present in the subsurface and much of the MRS is recreational areas intended for public use, and installing barriers around these is impracticable due to their location on or adjacent to open water. **High:** The installation of signs could be very effective at the MRS in warning users of potential risks due to remaining MEC.	**Easy**: Although fencing and guards are would be impracticable at the MRS, the installation of signs would be relatively easy to implement.	**Low**: Low costs associated with physical mechanisms	Signs	Long-term effectiveness is expected to require periodic inspection and sign maintenance within the MRS.	**High/Retained:** The installation of signs containing information on the potential remaining hazards at the MRS could be used to guide behavior and reduce the probability of MEC being handled.
Administrative Mechanisms: Educational programs including public information dissemination and advisories (e.g., written protocol or guidance, brochures, fact sheets, training programs, etc.,); management through permitting requirements.	**High**: Educational components work very well when tailored to the specific populations at risk of exposure through behavior modification. Multiple formats are available for use to convey information to target groups, and periodic inspections can be used to verify effectiveness in the future at both MRS.	**Easy**: Easily implementable for MRS where the nature and extent of hazards are known, and baseline risks have been established for all complete source/interaction/receptors pathways that are present. Execution is limited to primarily administrative functions. Based on data collected through the RI for the MRS, the nature and extent of munitions-related hazards has been fully characterized.	**Low**: Costs are variable based on level of effort.	Administrative to produce informational materials and provide training materials.	Landowners are aware of the history of the MRS, have been part of (or invited to participate) meetings regarding the results of MRS investigations and decision making, and are anticipated to continue to be receptive to informational materials provided in the future.	**High/Retained:** Institutional controls consisting of education programs tailored to the individuals most likely to be exposed to MEC present within the MRS could be used to guide behavior and reduce the probability of MEC being handled by unqualified individuals.

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On land, there are two basic forms of munitions detection. The first, visual searching, has been successfully used at a number of sites where munitions are located on the ground surface. When performing a visual search of a site, the area to be searched is typically divided into 5-foot lanes that are systematically inspected for munitions. A metal detector is sometimes used to supplement the visual search in areas where ground vegetation may conceal surface munitions. Typically, any munitions found during these searches is flagged or marked for immediate disposal.

The second form of detection, geophysics, includes various detection instruments designed to locate subsurface munitions and is integrated with the equipment and methods used for location positioning. Each piece of equipment has its own inherent advantages and disadvantages based on its operating characteristics. Thus, selecting the appropriate type of geophysical instrument is critical to the survey success. The instruments designed to locate subsurface munitions include magnetometers and electromagnetic instruments. Positioning technologies include various equipment and instruments that establish geo-referenced positions for subsurface anomalies detected using munitions detection technologies. The viability of positioning technologies is affected by site conditions, including terrain, tree canopy, and vegetation density.

Underwater detection technologies include geophysical sensors, bathymetric technologies, and sediment bottom imaging technologies. Underwater geophysical electromagnetic induction (EMI) and magnetometer technologies are largely the same as those used for land investigations; however, underwater investigations present more challenges. Geophysical sensors unique to the marine environment include sonar technologies. While sonar technologies are primarily used for bathymetric and sediment bottom imaging, there are some that can also aid in munitions detection.

The munitions detection technologies and positioning technologies are described and screened against the three criteria of effectiveness, implementability, and cost for use at the Former South Beach Moving Target Machine Gun and Katama Rocket Range MRS in Table 4-2 and Table 4-3, respectively. Site-specific performance results for equipment tested and employed during the RI at the MRS is incorporated into the technology screening to the extent possible.

4.3.4 Munitions Clearance

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

For a surface clearance operation, exposed munitions items are identified during the detection phase. The munitions items are then inspected, identified, collected (if possible), and transported

to a designated area for cataloging and eventual disposal. If it is determined during the inspection that the risk of moving an item is unacceptable, then it may be necessary to destroy the item in place.

Potential subsurface munitions identified by a geophysical survey or other detection methods requires excavation for clearance. Because the actual nature of the buried item cannot be determined without it being uncovered, the evacuation of nonessential personnel is necessary within a predetermined minimum separation distance (MSD). The MSD is based on the munition with the greatest fragmentation distance (MGFD) that may be present within the MRSs. All non-essential personnel and the general public must be evacuated from and maintain their distance beyond the MSD during the intrusive operations. The MSD may be reduced if sufficient mitigation techniques are implemented. Excavation takes place with either hand tools or mechanical equipment, depending on the suspected depth of the object. Once an item has been exposed, it is then inspected, identified, collected (if possible), and transported to a designated area for cataloging and disposal. If it is determined during the inspection that the item is munitions and the risk of moving the item is unacceptable, then it may be necessary to destroy the item in place. For intentional detonations, all personnel must observe the MSD. The MSD may be increased or decreased based on the actual item identified. Removal technologies applicable to clearance of munitions delineated at the Former South Beach Moving Target Machine Gun and Katama Rocket Range MRS are described in Table 4-4 and are screened against the three criteria of effectiveness, implementability, and cost.

4.3.5 MEC Disposal

Disposal/treatment technologies applicable to the anticipated MDAS waste stream are described in **Table 4-5**, and screened against the three criteria of effectiveness, implementability, and cost for the Former South Beach Moving Target Machine Gun and Katama Rocket Range MRS.

Table 4-2. Detection Technologies

Technology	Effectiveness	Implementability	Cost	Representative Systems	Notes	Viability at MRS/Status of Retention
Visual Searching	**Low - Moderate**: Effective for surface clearance in open areas with little ground cover. Not appropriate for subsurface clearance.	**Easy**: Easily implemented by qualified UXO Technicians and sweep personnel. Minimal to no impacts to cultural or natural resources.	**Low**: Lower than other methods that requires detection instrumentation and associated equipment.	NA	Typically supported with a flux-gate magnetometer or frequency-domain electromagnetic induction (FDEMI) metal detector.	**Low – Moderate/Retained**: The bulk of munitions on residential properties are located in the subsurface, although surface MD was detected. Where surface munitions exists on established recreational paths and the beach below the bluffs accessible to recreational users and private land owners, visual detection of munitions would be effective since the risk for exposure is at ground surface.
Flux-Gate Magnetometers: Flux-gate magnetometers measure the vertical component of the geomagnetic field along the axis of the sensor and not the total intensity of the geomagnetic field.	**Moderate - High**: Flux-gate magnetometers have been used as the primary detector in traditional mag & dig operations. There is a high industry familiarization. Detects ferrous objects only.	**Easy**: Light and compact. Can be used in any traversable terrain. Costs, transportation, and logistics requirements are equal to or less than other systems. Widely available from a variety of sources. Minimal to no impacts to cultural or natural resources.	**Low**: A number of flux-gate magnetometers have a low cost for purchase and operation compared to other detection systems. Lower than other methods on most terrains.	Schonstedt GA-52Cx Schonstedt GA-72Cd Foerster FEREX 4.032 Ebinger MAGNEX 120 LW Vallon EL1202D1 Chicago Steel Tape (Magna-Trak 102)	Analog output not usually co-registered with navigational data.	**Moderate – High/Retained**: Magnetometers were used effectively during the RI at the MRS; the nature of munitions characterized indicated practice aerial rockets with high ferrous content are present.
Proton Precession Magnetometers: Proton precession magnetometers measure the total intensity of the geomagnetic field. Multiple sensors are sometimes arranged in proximity to measure horizontal and vertical gradients of the geomagnetic field.	**Moderate**: Proton precession systems have greater sensitivities than flux-gate systems, but with a relatively slow sampling rate. There is a high industry familiarization. Detects ferrous objects only.	**Low**: Systems are similar to flux-gate systems in terms of operation and support. Generally is heavier and requires more battery power than flux-gate sensors. Sampling rate is low. Can be used in any traversable terrain. Is widely available from a variety of sources. Minor impacts to cultural or natural resources based on clearing of areas for data collection.	**Moderate**: Costs are higher than flux-gate systems. Proton precession systems often acquire digital data.	Geometrics G-856AX GEM Systems GSM-19T	Typically used as a base station for other digital magnetometer systems.	**Low/Not Retained**: Proton precession systems are not viable options as a standalone detection system at the MRS because of low implementability.
Optically Pumped Magnetometers: This technology is based on the theory of optical pumping and operates at the atomic level as opposed to the nuclear level (as in proton precession magnetometers).	**High**: This is the industry standard technology to detect MEC using magnetic data analysis. There is a high industry familiarization. Detects ferrous objects only.	**Moderate to Difficult**: Equipment is digital, rugged, and weather resistant. Common systems weigh more than most flux-gate systems. They are sensitive enough that corrections for heading error must be made. Can be used in most traversable terrain. Widely available from a variety of sources. Processing and interpretation requires trained specialists. Anomaly classification possibilities are limited to positional accuracy, magnetic susceptibility/magnetic moment estimates, and depth estimates. Detection capabilities are negatively influenced by iron-bearing rocks and soils, which are present in the MRS based on RI findings and known geology. Minor impacts to cultural or natural resources based on clearing of areas for high quality data collection.	**Moderate – High**: Has high purchase cost compared to other technologies. More dependent on terrain than flux-gate magnetometers. Lower costs can be realized when using arrays of multiple detector sensors.	Geometrics G-858 Geometrics G-822 Geometrics G-880 Geometrics G-882 GEM Systems GSMP-40 Scientrex Smart Mag G-tek/GAP TM4	Digital signal should be co-registered with navigational data for best results.	**Moderate/Retained**: Magnetometers were used effectively during the RI at the MRS; the nature of munitions characterized indicated practice rockets with high ferrous content are present; costs associated with addressing a 695 acre MRS are assumed to be high.

Technology	Effectiveness	Implementability	Cost	Representative Systems	Notes	Viability at MRS/Status of Retention
Time-Domain Electromagnetic Induction (TDEMI) Metal Detectors: TDEMI is a technology used to induce a pulsed magnetic field beneath the Earth's surface with a transmitter coil, which in turn causes a secondary magnetic field to emanate from nearby objects that have conductive properties.	**High**: TDEMI technology is the industry standard for MEC detection using electromagnetic data analysis. There is a high industry familiarization. Detects both ferrous and non-ferrous metallic objects. Can be limited by terrain. Geonics EM61-MK2 was tested and proven effective for digital geophysical mapping (DGM) during the RI.	**Easy - Moderate**: Sensors are typically larger than digital magnetometers. Can be used in most traversable terrain. Most commonly used instrument and is widely available. Processing and interpretation are relatively straightforward. Anomaly classification possibilities exist for multi-channel systems. Minor impacts to cultural or natural resources based on clearing of areas for high quality data collection.	**Moderate – High**: Has high purchase cost compared to other technologies. Dependent on terrain. Lower costs can be realized when using arrays of multiple detector sensors.	Geonics EM61-MK1 Geonics EM61-MK2 Geonics EM61-MK2A Geonics EM61-MK2 HP Geonics EM61 HH Geonics EM63 Zonge Nanotem G-tek/GAP TM5-EMU Vallon VMH3 Schiebel AN PSS-12 Battelle TEM-8	Digital signal should be co-registered with navigational data for best results. Detection depths are highly dependent on coil size and transmitter power.	**Moderate/Retained**: This technology was proven effective in open and accessible areas at the MRS during the RI The technology is viable in most environments but has not been demonstrated within the high energy environment associated with the nearshore currents at this location
Advanced Electromagnetic Induction (EMI) Sensors and Anomaly Classification: Advanced sensors have the ability to precisely capture measurements from enough locations to sample all principal axis responses of an anomaly/item of interest. This provides the necessary information for analysis and classification of hazardous and non-hazardous items.	**Moderate – High**: Some sensors may be used in production mode, but most require target locations from previous DGM survey to navigate to for static measurements. Greatest ability of all sensors for the classification of anomalies as either MEC or non-hazardous items. Detects both ferrous and non-ferrous metallic objects.	**Moderate**: Most require the use of a vehicle to tow the sensor to the location of an anomaly, although some smaller, man-portable systems are in development. One-meter-wide coil width (or greater) limits accessibility in forested or steeply sloped areas. Advanced analysis is required to effectively use the data acquired by the sensors and accurately classify detected anomalies as MEC or non-hazardous material that will not be removed. Minor to moderate impacts to cultural or natural resources based on clearing of areas for high quality data collection.	**High**: Use of the advanced systems often represents additional surveying and processing costs, which may be largely offset by the decrease in the intrusive investigation costs.	ALLTEM Berkeley UXO Discriminator (BUD) BUD Handheld Geometrics MetalMapper (MM) Man Portable Vector (MPV)TEMTADS TEMTADS 2x2	Sensors have limited industry availability. Requires advanced training for operation, data processing, and analysis.	**Low – Moderate/Not Retained**: This technology has been demonstrated and validated by the DoD's Environmental Security Technology Certification Program (ESTCP). The technology would only be viable on beach portion of MRS. Only the MetalMapper is currently commercially available. ~~All other systems are under development or in testing.~~
Frequency-Domain Electromagnetic Induction (FDEMI) Metal Detectors: FDEMI sensors generate one or more defined frequencies in a continuous mode of operation.	**Moderate - High**: Some digital units have been used as the primary detector in highly ranked systems. Demonstrates capability for detecting small items using handheld units. Is not optimum for detecting deeply buried objects. Lower industry familiarization than time domain electromagnetic systems. Detects both ferrous and non-ferrous metallic objects. The White's All-Metals Detector was proven effective during the RI at the MRS.	**Easy**: Hand-held detectors are generally light and compact. Can be used in any traversable terrain. Most are handheld systems. Widely available from a variety of sources. Minimal to no impacts to cultural or natural resources.	**Moderate**: Instruments are slow and can detect very small items. Common handheld detectors are much lower cost than digital systems.	Schiebel ANPSS-12 White's All Metals Detector Fisher 1266X Foerster Minex Minelabs Explorer II Minelabs F3 (UXO and Compact versions) Geophex GEM 3 Apex Max-Min Ceia CMD	Analog output not usually co-registered with navigational data. Digital output should be co-registered with navigational data	**Moderate – High/Retained**: This technology was proven effective at the MRS during the RI. FDEMI detects all metals, instead of only ferrous items.

Technology	Effectiveness	Implementability	Cost	Representative Systems	Notes	Viability at MRS/Status of Retention
Sub Audio Magnetics: Sub-audio magnetics is a patented methodology by which a total field magnetic sensor is used to simultaneously acquire both magnetic and electromagnetic response of subsurface conductive items.	**Low:** Detects both ferrous and non-ferrous metallic objects. Capable tool for detection of deep MEC. Low industry familiarization. System has seen limited application.	**Difficult:** High data processing requirements. Available from a few sources. High power requirements. Has longer than average setup times. Minor impacts to cultural or natural resources based on clearing of areas for high quality data collection.	**High:** Has higher than average operating costs and low availability.	G-tek/GAP SAM	Not commercially available. No established track record.	**Low/Not Retained:** Difficult to implement, no proven track record, and not commercially available.
Magnetometer-Electromagnetic Detection Dual Sensor Systems: These dual sensor systems are ~~expected to be~~ effective in detecting MEC as magnetometers respond to large, deep ferrous targets and TDEMI sensors respond to nonferrous metallic targets.	**High:** Collects co-located magnetic and electromagnetic data to differentiate between ferrous and non-ferrous metallic objects. Has medium industry familiarization.	**Moderate - Difficult:** Increased data processing requirements. Similar terrain constraints to time-domain electromagnetic systems. Available from few sources. Minor impacts to cultural or natural resources based on clearing of areas for high quality data collection.	**High:** Initial purchase price is high. Labor costs can be reduced when using a towed array platform. Limited availability.	MSEMS (man-portable EM61-Mk2 & G-822) VSEMS (vehicular EM61-Mk2 & G-822) USEMS (underwater)	Only available from a few sources.	**Low/Not Retained:** Difficult to implement and not readily available equipment (only available from a few sources).
Airborne Synthetic Aperture Radar: This airborne method uses strength and travel time of microwave signals that are emitted by a radar antenna and reflected off a distant surface object.	**Low:** Detects both metallic and non-metallic objects. Only detects largest MEC on or near ground surface. Low industry familiarization. Effectiveness increases when used for wide area assessment in conjunction with other airborne technologies.	**Difficult:** Requires aircraft and an experienced pilot. Substantial data processing and management requirements. Available from few sources. Minimal to no impacts to cultural or natural resources.	**High:** Aircraft and maintenance costs must be included. Processing costs are higher than other methods.	Intermap Technologies Corp., (STAR systems)	Typically not applied to detect MEC.	**Low/Not Retained:** Low effectiveness in subsurface clearance activities.
Airborne Laser and Infrared Sensors: Infrared sensors and laser technologies can be used to identify objects by measuring their thermal energy signatures, or distance through light detection and ranging (laser pulse). UXO or DMM on or near the soil surface possess different heat capacities than the surrounding soil, and this temperature difference can be detected and used to identify MEC.	**Low:** Detects both metallic and non-metallic objects. Low industry familiarization. Effectiveness increases when used for wide area assessment in conjunction with other airborne technologies.	**Difficult:** Requires aircraft and an experienced pilot. Substantial data processing and management requirements. Available from few sources. Minimal to no impacts to cultural or natural resources.	**High:** Aircraft and maintenance costs must be included. Processing costs are higher than other methods.	Riegl LMS-Q560, Leica ALS 50-II / ALS 60/ALS 70 FLIR Systems StarSAFIRE 230-HD	Typically not applied to detect MEC.	**Low/Not Retained:** Difficult to implement and not readily available equipment (only available from a few sources).
Synthetic Aperture Sonar: SAS uses multiple pulses to create a large synthetic array. SAS uses a small sonar array to synthesize a much larger array. SAS uses lower operating frequencies, increasing the range of the sonar signal without affecting the performance. SAS systems also have a wider field of view, resulting in a larger angular response from objects.	**Moderate**: SAS technology is still relatively new. Munitions detection capability versus proud targets is promising, but limited demonstrations. Low-frequency prototype SAS has demonstrated detection of partially buried objects.	**Moderate:** Synthetic aperture sonar moves sonar along a line and illuminates the same spot on the seafloor with several pings.	**Moderate**	Kongsberg HISAS 1030	Relatively new and not widely used.	**Low/Not Retained:** Effectiveness as detection technology is not yet proven.
BOSS: BOSS is wideband sonar that generates three-dimensional imagery of buried, partially buried, and proud targets. It is a type of SAS system that uses hydrophone receiver arrays to transmit an omnidirectional acoustic pulse and to record the energy backscatter from both the sediment surface and sediment layers.	**Moderate**: Known systems are still experimental; currently demonstrated detection capabilities show very consistent detection through 30 cm of sand. Classification capabilities unknown.	**Moderate:** BOSS generates images of objects buried in underwater sediments.	**High:**	CHIRP Lab SAS 40 Channel CHIRP Lab 252 Channel	Not widely used and validation studies have been performed. Only available from a few sources.	**Low/Not Retained:** Effectiveness as detection technology is not yet proven.

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Table 4-3. Positioning Technologies

Technology	*Effectiveness*	*Implementability*	*Cost*	*Representative Systems*	*Notes*	*Viability at MRS/Status of Retention*
Differential Global Positioning System (DGPS): Global Positioning System (GPS) is a worldwide positioning and navigation system that uses a constellation of 29 satellites orbiting the Earth. GPS uses these satellites as reference points to calculate positions on the Earth's surface. Advanced forms of GPS, like DGPS, can provide locations to centimeter accuracy.	**High**: Very effective in open areas for both digital mapping and reacquiring anomalies. Very accurate when differentially corrected. Commonly achieves accuracy to a few centimeters, but degrades when minimum satellites are available.	**Easy**: Easy to operate and set up. Available from a number of vendors. Better systems are typically rugged and very durable. However, significant work time can be lost when insufficient satellites are available because of topography and tree canopy. Minor impacts to cultural or natural resources based on clearing of areas for high quality data collection.	**Moderate**: Requires rover and base station units. Survey control points required for high accuracy results.	Leica GPS 1200 Trimble GeoXT/R6/R8/R10 Thales Ashtech Series 6500 May be paired with Ultra Short Baseline acoustic positioning for underwater towed sensors	Recommended in open areas.	**High/Retained:** Was used during the RI in the Former South Beach Moving Target Machine Gun and Katama Rocket Range MRS effectively.
Robotic Total Station (RTS): RTS is a laser-based survey station that derives its position from survey methodology and includes a servo-operated mechanism that tracks a prism mounted on the geophysical sensor.	**Moderate - High**: Effective in open areas for both digital mapping and reacquiring anomalies. Effective around buildings and sparse trees. Is being used in heavily wooded areas with moderate success. Commonly achieves accuracy to a few centimeters.	**Easy - Moderate**: Relatively easy to operate with trained personnel. Requires existing control. Minor impacts to cultural or natural resources based on clearing of areas for high quality data collection.	**High**: Operates as a stand-alone unit. Typically requires survey control points but can be used in a relative coordinate system.	Leica RTS 1100 Trimble Model 5600/S6/VX/IS	Recommended in open areas and in moderately wooded areas. Typically used with TDEMI metal detectors (like Geonics EM61-MK2) and digital magnetometers (like Geometrics G-858). Integrated Systems (IS) combine DGPS and RTS for use in highly diverse terrains.	**Moderate – High/Retained**: This technology was used for anomaly reacquisition during the RI. RTS can also be used for data positioning for digital detector systems in moderately wooded areas.
Fiducial Method: The fiducial method consists of digitally marking a data string with an indicator of a known position. Typically, markers are placed on the ground at known positions (e.g., 25 feet).	**High**: Moderate to high effectiveness when performed by experienced personnel. Low effectiveness when used by inexperienced personnel. Commonly achieved accuracy is 15 to 30 centimeters.	**Moderate - Difficult**: Application requires a constant pace and detailed field notes. Can be used anywhere, with varying degrees of complexity in the operational setup. Requires "back end" data processing.	**Moderate**: Minimal direct costs associated with this method but it is labor intensive. Poor results may negatively impact costs associated with target resolution.	NA	Requires very capable operators. Useful method if digital positioning systems are unavailable.	**Low/Not Retained:** This method is more difficult to implement accurately than other methods, such as DGPS.
Odometer Method: This method utilizes an odometer that physically measures the distance traveled.	**Moderate**: Moderate to high effectiveness when performed by experienced personnel. Low effectiveness when used by inexperienced personnel. Commonly achieved accuracy is 15 to 30 centimeters in line and 20 to 80 centimeters on laterals.	**Moderate - Difficult**: Setup and operation affected by terrain. Requires detailed field notes and setup times can be lengthy. Can be used anywhere, with varying degrees of complexity in the operational setup. Requires "back end" data processing.	**Low**: Minimal direct costs associated with this method; however, poor results may negatively impact costs associated with target resolution.	NA	Requires very capable operators. Useful method if digital positioning systems are unavailable.	**Low/Not Retained:** This method is impractical for use given the anticipated need for accurate anomaly resolution during a future response action.
Acoustic Method: This navigation system utilizes ultrasonic techniques to determine the location of a geophysical instrument each second. It consists of three basic elements: a data pack, up to 15 stationary receivers, and a master control center.	**High:** Underwater acoustical systems determine the position of a vehicle or diver by acoustically measuring the distance from a vehicle or diver interrogator to three or more seafloor deployed baseline transponders. These techniques result in very high positioning accuracy and position stability that is independent of water depth. It can reach a few centimeters accuracy. Accuracy on land is greater than 15 cm.	**Difficult**: Difficult to set up and setup requirements are complex. (However, more easily set up and used by trained personnel.)	**High**: Lengthy setup time can be reduced by using trained personnel. Requires more than one operator.	Long-baseline (LBL) systems Ultra-short-baseline (USBL) systems Short-baseline (SBL) systems USRADs		**Low/Not Retained**: This technology is difficult to implement without trained and experienced operators.

Technology	*Effectiveness*	*Implementability*	*Cost*	*Representative Systems*	*Notes*	*Viability at MRS/Status of Retention*
Jackstays: Jackstay is an underwater grid system. Accurate positioning if the corners are accurately done. A line (moveable) is attached to lines connected to the corners. The divers search along the movable line changing its position after each pass. When a diver finds a suspect item, a float is released to mark the positions. The surface support boat then marks the float with GPS.	**Highly effective:** Once set up, this system is effective underwater, especially in shallower depths. The effectiveness of jack stays can be dependent on currents and waves.	**Easy to Moderate:** This technology can be easily implemented underwater at shallower depth. The set up is sometimes tedious depending on how rough the water is.	**Moderate:** Since this technology requires both divers and support crew, it can be moderately expensive in field labor. However, the equipment is low in cost.	NA	Requires trained UXO divers and boat support crew.	**High/Retained:** This technology is proven and is highly effective underwater where visibility is limited.

Table 4-4. Removal Technology

Technology	Effectiveness	Implementability	Cost	Representative Systems	Notes	Viability at MRS/ Status of Retention
Hand Excavation: Technique includes digging individual anomalies using commonly available hand tools.	**High**: This is the industry standard for munitions removal. It can be very thorough and provides an excellent means of data collection. For surface removals, this method would be highly effective. For subsurface removals, as depth and extent of removal increases the labor and time duration required for hand excavation also increases.	**Easy - Moderate**: Hand excavation can be accomplished in almost any terrain and climate. Limited only by the number of people available. Minimal to no impacts to cultural or natural resources.	**Moderate**: Is the standard by which all others are measured.	Probe, trowel, shovel, pick axe.	Locally available and easily replaced tools.	**High/Retained:** This technology was successfully used during the RI and the depth at which MEC were detected during the RI are suitable for this technology.
Mechanical Excavation of Individual Anomalies: This method uses commonly available mechanical excavating equipment to support hand excavations.	**High**: Used in conjunction with hand excavation when soil is too hard, excavation depths are deep and addressing areas with higher densities of munitions causing time delays, or safety concerns during hand excavation. Method works well for the excavation of deep single anomalies to remove overburden.	**Moderate**: Equipment can be rented, is easy to operate, and allows excavation of anomalies in hard soil. Mobilization and use of equipment within the water portions of the MRS will require a boat.	**Moderate**:	Tracked mini-excavator or wheeled backhoe. Multiple manufacturers. Excavator with floatation tracks such as a marsh buggy.		**Moderate / Retained:** For deep subsurface anomalies not easily accessible by hand excavation. Would be effective at digging anomalies within water and will minimize diver time spent hand digging.
Mass Excavation and Sifting: Armored excavation and transportation equipment to protect the operator and equipment from unintentional detonation. Once soil has been excavated and transported to the processing area, it is then processed through a series of screening devices and conveyors to segregate MEC from soil.	**High**: Process works very well in heavily contaminated areas and in sandy environments. Can separate several different sizes of material, allowing for large quantities of soil to be returned with minimal screening for munitions.	**Difficult**: Earth moving equipment is readily available; however, armoring is not as widely available. Equipment is harder to maintain and may require trained heavy equipment operators. Only feasible for the dunes within the MRS. Restoration required for disturbed areas. Impacts to cultural and natural resources because roadways, stockpiles, and material laydown areas would need to be established.	**High**: Mass earth moving equipment is expensive to rent and has the added expense of high maintenance and restoration costs.	Many brands of heavy earth moving equipment, including excavators, off-road dump trucks, and front-end loaders. Trommel, shaker, rotary screen from varying manufacturers.	Can be rented and armor can be installed, and equipment delivered almost anywhere. Significant maintenance costs.	**High/ Retained:** Since the majority of MEC is anticipated to remain in the dunes, mass excavation and sifting of the dunes are viable options.
Magnetically Assisted Removal: Magnets are used to separate conductive material from soils.	**Moderate**: Primarily used in conjunction with mass excavation and sifting operations. Can help remove metal from separated soils, but does not work well enough to eliminate the need to inspect the smaller size soil spoils. Magnetic systems are also potentially useful to help with surface removal of MEC and surface debris, but the size of MEC characterized during the RI would be unlikely to be picked up by manually-operated rollers. Mechanical systems would be required to assist with surface removal operations.	**Difficult**: Magnetic separators are easily obtained from sifting equipment distributors and are designed to work with their equipment. Major impacts to cultural and natural resources because roadways, stockpiles and material laydown areas would need to be established for both earthmoving and sifting equipment that support magnetic operations.	**Low**: This method adds very little cost to the already expensive sifting operation.	Magnetic rollers or magnetic conveyors are limited in availability but can be procured for use on standard readily available sifting equipment noted above.	Installed by sifting equipment owner.	**Low/Not Retained:** Primarily used in conjunction with mass excavation and sifting operations. The amount of MEC at the MRS and the relatively large area does not require mass excavation.
Remotely Operated Removal Equipment: this equipment has additional control equipment that allows the equipment to be operated remotely.	**Low**: Remotely operated equipment reduces productivity and capability of the equipment. Method is not widely used and is not yet proven to be an efficient means of munitions removal.	**Difficult**: Uses earth moving equipment, both mini-excavator type and heavier off-road earth moving equipment. Machinery is rigged with hydraulic or electrical controls to be operated remotely. Not feasible for the heavily vegetated areas within the MRS. Restoration required for disturbed areas. Major impacts to natural resources because roadways, stockpiles, and material laydown areas would need to be established for earth moving equipment.	**High**: Has a combined cost of the base equipment plus the remote operating equipment and an operator. Remote operation protects the operator, but can create high equipment damage costs.	Many tracked excavators, dozers, loaders, and other equipment types have been outfitted with robotic remote controls.	Explosive Ordnance Disposal (EOD) robots are almost exclusively used for military and law enforcement reconnaissance and render-safe operations. They were not evaluated for MEC applications.	**Low/Not Retained:** This technology has a low viability at the MRS because of low effectiveness and difficult implementation.

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Table 4-5. MEC Disposal Technologies

Technology	Effectiveness	Implementability	Cost	Representative Systems	Notes	Viability at MRS/ Status of Retention
Blow-in-Place (BIP): BIP is the destruction of MEC for which the risk of movement beyond the immediate vicinity of discovery is not considered acceptable. Normally, this is accomplished by placing an explosive charge alongside the item.	**High:** Each MEC item is individually destroyed with subsequent results individually verified using quality assurance and quality control. BIP yields unconfined releases of MC and MD, which can be restricted using mitigation techniques.	**Moderate to Easy:** Field-proven techniques, transportable tools, and equipment; suited to most environments. Public exposure can limit viability of this option. Mitigation techniques can further improve implementation. Major impacts to cultural and natural resources if item cannot be moved away from sensitive cultural or natural resources. Trees and plants could be moved, but cultural resources would not be movable to mitigate impacts. Mitigation techniques may limit damages to these resources.	**Medium:** Manpower intensive. Costs increase in areas of higher population densities or where public access must be monitored and controlled. .	Electric demolition procedures, non-electric demolition procedures.	Disposition of resultant waste streams must be addressed in BIP operations planning.	**High/Retained:** Used for items that are deemed unsafe to move. Technology has been proven effective in similar field conditions.
Consolidated Shots: Consolidated detonations are the collection, configuration, and subsequent destruction by explosive detonation of MEC for which the risk of movement has been determined to be acceptable.	**High:** Limited in use to MEC that are deemed safe to move. BIP yields unconfined releases of MC and MD, which can be restricted using mitigation techniques. This method was effectively used to consolidate MPPEH for venting at a common location on daily schedule.	**Moderate to Easy:** Generally employs the same techniques, tools, and equipment as BIP procedures. Requires larger area and more mitigation. However, the common location for detonation and ability to schedule events enables better control and management of impacts to the public. Most approved mitigation techniques. are not completely effective or applicable for these operations	**Medium:** Manpower intensive, may require materials handling equipment for large-scale operations.	Electric demolition procedures, non-electric demolition procedures, forklifts and cranes.	Disposition of resultant waste streams must be addressed.	**Medium/Retained:** Only used for items that are deemed safe to move. Requires an increase in explosive weight over what would be used for a single explosive demolition shot. Proven technology for addressing MEC and allow for disposal as a MDAS waste stream.
Laser Initiation: Laser initiation involves portable, vehicle-mounted lasers that may be used to heat surface MEC and induce detonation.	**Medium:** Still in development, although currently deployed overseas for testing. Tests show positive results for 81 millimeter (mm) and below, with reported success on munitions up to 155 mm. Produces low order type effect; subsequent debris still requires disposition.	**Low:** MEC targets must be exposed and on surface for attack by directed beam. System does require approach and placement of fiber-optic cable at appropriate position of suspected item. Laser systems still addressing power, configuration, transportability, and logistics issues. Potential impacts to natural resources because roadways and staging areas would need to be established for equipment.	**Low - Medium:** Greatly reduced manpower; added equipment, transportability and logistics concerns; no explosives required by system.	ZEUS-HLONS GATOR Laser	Disposition of resultant waste streams must be addressed in BIP operations planning and Laser initiation processes are still in the developmental stage and not used commercially.	**Low/Not Retained:** This technology is still in the developmental and is not commercially used.
Contained detonation chambers (CDCs): CDCs involve destruction of certain types of munitions in a chamber, vessel, or facility designed and constructed specifically for the purpose of containing blast and fragments. CDCs are used to destroy MEC while containing both the blast effects and the secondary waste stream within the closed system and can only be employed for munitions for which the risk of movement has been determined acceptable.	**Medium:** CDCs successfully contain hazardous components. Commonly used for fuzes and smaller explosive components. May not be used for larger munitions items found at the MRSs. Limited in use to munitions that are "acceptable to move."	**Low:** Designed to be deployed at the project site. Logistically difficult to mobilize to the site. Could require boat transport since weight of CDC may not allow for transporting over the beach. Potential impacts to natural resources because roadways and staging areas would need to be established for equipment. Service life and maintenance are issues. Requires substantial additional handling and transport of MEC and requires items to be safe to move. Flashing furnaces have low feed rates because of safety concerns. Produces additional hazardous waste streams.	**Medium-High:** Possible construction required (e.g., berms and pads). Low feed rates equal more hours on site. Significant requirements for maintenance of system.	Kobe Blast Chamber	CDC use is limited to items that are within the net explosive weight that the system is approved to destroy and that contain fill that the unit is approved to destroy. This includes conventional munitions that contain energetics, WP, riot agents, propellants, and smoke. Air handling and filtration may be required depending on the munitions being detonated.	**Low/Not Retained:** Assumed to be very difficult to mobilize to the site and amount and type of MEC anticipated to be identified during removal can be disposed of more easily through other methods (BIP or consolidated shot).

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4.4 Viable Technologies for the Former South Beach Moving Target Machine Gun and Katama Rocket Range MRS

The technologies listed in Tables 4-1 to 4-5 that are the most viable options for the Former South Beach Moving Target Machine Gun and Katama Rocket Range MRS are summarized in Table 4-6 and are included in the process options assembled for remedial alternatives in Section 5. Technologies summarized in Table 4-6 are the most viable options, and the majority have been demonstrated to be effective at the MRS during the RI or at a similar site.

Table 4-6. Viable Technologies

Land Use Controls	Detection		Removal	Disposal/Treatment
Institution Controls (Educational)	**Geophysical Detection**	**Positioning**		
▪ Signs ▪ Preparation and distribution of informational materials ▪ Training for local community	▪ DGM, including TDEMI metal detector and advanced EMI sensors for anomaly classification. The sensors deemed viable for accessible areas include the EM61-MK2 and TEMTADS 2x2. ▪ Analog (mag & dig), including flux-gate and optically-pumped magnetometers. These instruments were successfully used at the MRS during the RI and are the most viable analog instruments for use.	▪ Robotic Total Station (with DGM). ▪ Global Position Systems (with DGM). ▪ Jackstays	▪ Hand excavation. ▪ Mechanical excavation. ▪ Mechanical Excavation of Individual Anomalies ▪ Mass excavation with sifting.	▪ Off-site recycling - munitions recovered during clearance would be sent off-island for recycling following verification as MDAS and certification that the material is free of explosives. ▪ Blown-in-place and consolidated shot treatment technologies retrained for MPPEH discovered during clearance activities similar to procedures employed during the RI.

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5.0 Development and Screening of Alternatives

In this section, the technologies deemed viable for use at the Former South Beach Moving Target Machine Gun and Katama Rocket Range MRS (see Section 4) are assembled into remedial alternatives and initially screened against the three criteria of effectiveness, implementability, and cost in a similar manner to the technology screening presented in Section 4. The remedial alternatives described and determined viable during the initial screening are further evaluated against the NCP criteria independently in a detailed analysis and against each other in a comparative analysis presented in Section 6 of this FS Report.

5.1 Development of Remedial Alternatives

The following remedial alternatives have been assembled from viable technologies and general response actions for the Former South Beach Moving Target Machine Gun and Katama Rocket Range MRS:

- Alternative 1 – No Action
- Alternative 2 – LUCs
- Alternative 3 – Land Area Only Subsurface Clearance with LUCs (309 Acres)
- Alternative 4 – Complete subsurface clearance Land and Water (695 Acres)

In accordance with DoD Manual 4715.20 (2012), a minimum of three alternatives for each MRS are required. One alternative must consider no action alternative, a second must consider an action to remediate the site to a condition that allows unlimited use/unrestricted exposure (UU/UE), and a third alternative will consider an action to remediate the site to a protective condition that requires LUCs. For the Former South Beach Moving Target Machine Gun and Katama Rocket Range MRS, Alternative 1 meets the requirement for a no action alternative. Alternatives 2 and 3 meet the requirement for an alternative with LUCs, and Alternative 4 meets the requirement for an alternative that will achieve UU/UE.

5.2 Alternative 1 – No Action

5.2.1 Description

A "no action" alternative is required by the NCP to be developed during a FS to provide a baseline for comparison against other contemplated alternatives. In Alternative 1, the government would take no action with regard to locating, removing, and disposing of any potential MEC present within the MRS. In addition, no public awareness or education training would be initiated with regard to the risk of encountering MEC. For this alternative, it is

assumed that no change to the current land use of the MRS would occur. There are no costs expected for this alternative as there is no government action and no long-term management (LTM).

5.2.2 Evaluation

Effectiveness: This alternative would not be effective at achieving the RAO of protecting recreational users, landowners, visitors, and workers at the MRS from explosive hazards associated with handling munitions encountered during residential, construction/maintenance, and recreational activities performed at ground surface and in subsurface soil.

Implementability: This alternative is considered easy to implement. No construction, maintenance or monitoring would be required with this alternative.

Relative Cost: No costs are associated with this alternative since no action is required.

Summary: The No Action alternative will be retained for detailed analysis as required by the NCP.

5.3 Alternative 2 – Land Use Controls

5.3.1 Description

Risks related to encountering MEC may be managed for the MRS through a limited action alternative consisting of various LUCs. The implementation of a LUC alternative based on public awareness and education components in the Former South Beach Moving Target Machine Gun and Katama Rocket Range MRS would provide a means for USACE to coordinate an effort to reduce munition encounters by workers and recreational users and visitors (i.e., unqualified and untrained personnel) through behavior modification. Successful implementation of LUC would be contingent upon the cooperation and active participation of the workers and recreational users and visitors and authorities of the Army and other government agencies to protect the public from explosives hazards. Alternative 2 for the Former South Beach Moving Target Machine Gun and Katama Rocket Range MRS was developed using USACE guidance EP 1110-1-24 for *Establishing and Maintaining Institutional Controls for Ordnance and Explosive Projects* (USACE, 2000) as a reference.

Three forms of public informational materials for education would be LUC components under Alternative 2.

1. Development and distribution of informational materials to periodically provide awareness to property owners and town authorities of the presence of munitions, and the DoD policy referred as "the 3Rs" to be able to recognize, retreat and report any

future munitions that is encountered while performing maintenance, improvement, or construction activities on their property.

2. For the general public accessing the MRS for recreational/visiting purposes, installation/maintenance of signage at strategic access points in the MRS would be used to alert users of the MRS history and nature of munitions present, in addition to public safety information (i.e., 3Rs).

3. An educational program is considered under Alternative 2 including providing periodic training on-island for the local community to provide awareness on the munitions characterized at the MRS, and the 3Rs policy that will be used for future discoveries at the MRS and displayed on signage posted in and around the MRS. Attendance will be open to the public.

The LUCs that would remain in-place to address residual hazards or risks must be managed in the long-term. LUC enforcement, review of site conditions, and maintenance activities for this alternative is a means of performing long-term management following achievement of response complete and can be performed on a periodic or as-needed basis. LUC enforcement activities would include providing recurring awareness training materials and reproduction of informational materials. This alternative will require maintenance of signs and Five-Year Reviews.

5.3.2 Evaluation

Effectiveness: The effectiveness of this alternative is considered moderate. The RAO of protecting recreational users, landowners, visitors, and workers at the MRS from explosive hazards associated with handling munitions encountered during residential, construction/maintenance, and recreational activities performed at ground surface and in subsurface soil would be achieved through exposure controls. Potential impacts to human health and the environment would be minimal during the implementation of the LUCs. However, the reliability of LUCs to prevent exposure places the burden on site users to follow the 3Rs rather than removing the risk permanently.

Implementability: Implementation of this alternative is considered easy. It is technically easy to install signs, provide information to the public, and develop and provide training materials to the landowners, local government and TTOR. This alternative will require maintenance of signs and Five-Year Reviews. Administratively, this alternative is easy to implement as it does not require specialized equipment or training.

Relative Cost: Costs for this alternative are expected to be high ($1 to $5M).

Summary: While the effectiveness of Alternative 2 (LUCs) is limited, it is retained for detailed analysis because it will achieve the RAO and can be easily implemented.

5.4 Alternative 3 – Land Area Only Subsurface Clearance with LUCs (309 Acres)

5.4.1 Description

Alternative 3 includes removal of subsurface munitions hazards to 3 feet below ground surface on the land and beach within the MRS (309 acres), as shown on Figure 5-1. LUCs would be implemented on the remaining ocean area. The following general tasks would be included in Alternative 3.

- Mobilization
- Site Management
- Environmental Coordination and Environmental Monitoring
- Botanical and wildlife survey and habitat evaluation
- Survey and positioning
- Brush and vegetation clearing (where needed)
- Digital geophysical mapping and data analysis
- Anomaly reacquisition and resolution
- Mechanical sifting of dunes.
- MD removal
- Munitions documented as safe (MDAS) waste stream treatment (off-site) disposal
- Site restoration
- Post construction vegetation monitoring
- Demobilization
- Development and reproduction of training materials
- Annual sign maintenance

DGM and data analysis would be utilized for the 309 acre beach and land portions of the MRS, followed by anomaly reacquisition and resolution and munitions removal and disposal. Prior to DGM activities, a small portion of the area would require vegetation removal to gain access during the clearance. Disposal of removed vegetation will be coordinated with MADCR, TTOR, the Town of Edgartown, landowners, and USACE subject matter experts during the development of the remedial action work plan to ensure the habitat is not detrimentally affected. Detection of munitions would be performed using digital detection instrumentation such as the EM61-MK2 that employs TDEMI technology. Positioning for the digital instrumentation would be conducted using a GPS. These technologies are anticipated to be viable based on MRS-specific munitions and physical characteristics and successful past use at the MRS during the RI. Rocket motor

bodies, due to their size, can be reliably detected to 4 ft bgs however, if anomalies are detected below a dug anomaly, they will be investigated, removed, and properly disposed of.

Anomalies would be reacquired using a robotic total station. Intrusive activities would be performed using both mechanized equipment and hand-tools and restoration of disturbed areas would be required. Mechanized equipment will be used to remove the dunes in the vicinity of the rocket targets and in areas of high anomaly densities. Any MPPEH recovered during the clearance would be BIP or consolidated for disposal. The MDAS would be consolidated during removal, certified as explosive-free MDAS, and disposed off-site for recycling.

Because sensitive species are known to exist within the MRS, this alternative will require coordination with MA NHESP, TTOR, and USFWS. Coordination with USFWS will establish conditions for working in areas where federally listed species may be present. A rare plant and wildlife habitat evaluation will be conducted during development of the work plan in accordance with MA NHESP guidelines. Fieldwork would be scheduled to avoid sensitive species as much as possible. In addition, biological monitoring during the remedial action and habitat restoration would be required as a mitigation measure.

Unavoidable adverse impacts to vegetation would occur as a result of this alternative and would require restoration in areas where vegetation was cleared. Detailed restoration measures would be presented in the remedial action work plan coordinated with stakeholder, landowners, and resource agencies.

LUCs would be implemented as described in Alternative 2. This alternative would require Five-Year Reviews; however, these reviews are not considered as part of the remedy for Alternative 3.

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FIGURE 5-1

Alternative 3: Partial Subsurface Clearance with LUCS, Former South Beach Moving Target Machine Gun and Katama Rocket Range MRS, Martha's Vineyard, MA

0 1,250 2,500 3,750 5,000 6,250 Feet	0 200 400 600 800 1,000 Meters	04/13/2015	Rev:	Drawn: JBO	Chk: DMS	SBeach_Alt_3_FS.mxd	PROJ: 562910000

5.4.2 Evaluation

Effectiveness: This alternative is considered moderately effective. The RAO of protecting recreational users, landowners, visitors, and workers at the MRS from explosive hazards associated with handling munitions encountered during residential, construction/maintenance, and recreational activities performed at ground surface and in subsurface soil would be achieved through removal of munitions from the beach and land, and exposure controls for the ocean portion of the MRS. LUCs would be effective within the inland water and ocean areas of the MRS to prevent exposure to MEC. This alternative uses proven and reliable technologies that will permanently remove the MEC hazard from a portion of the site. While this alternative presents potential impacts to human health and the environment during implementation (UXO personnel and beach loss), the impacts will be minimized through use of safety plans and coordination with MADEP, MA NHESP, and TTOR as necessary, and mitigated by site restoration.

Implementability: The implementability of Alternative 3 is considered moderate. This alternative can be readily implemented and resources and equipment are available. This alternative will require maintenance of signs and Five-Year Reviews, and specialized equipment and personnel with specialized training will be required to successfully implement a subsurface clearance.

Relative Cost: The cost of conducting this alternative (Partial Subsurface Clearance with LUCs) is considered high (>$5M).

Summary: Since this alternative would be moderately effective in achieving the RAO and reducing the hazards associated with of munitions, this alternative will be retained for detailed analysis.

5.5 Alternative 4 – Complete subsurface clearance Land and Water (695 Acres)

5.5.1 Description

Alternative 4 includes clearing the entire 695 acre MRS of subsurface munitions to 3 feet below ground surface, as illustrated in Figure 5-2. The following general tasks would be included in Alternative 4.

- Mobilization
- Site management
- Environmental Coordination and Environmental Monitoring
- Botanical and wildlife survey and habitat evaluation
- Survey and positioning

- Brush clearing (where needed)
- "Mag & dig" within the ocean area
- Digital geophysical mapping and data analysis within the beach and land areas
- Anomaly reacquisition and resolution
- MD removal
- Mechanical sifting of dunes
- MDAS waste stream treatment (off-site) disposal
- Site restoration
- Post construction vegetation monitoring
- Demobilization
- Development and reproduction of training materials
-

After all clearance operations are complete, a review of the site will be made (similar to a CERCLA Five-Year Review) that will ensure the effectiveness of the remedial actions for UU/UE.

Alternative 4 requires clearance activities in all three areas of the MRS: beach, land, and ocean (Figure 5-2).

Beach and Land: Some vegetation clearance will be necessary to gain access during the clearance. Disposal of removed vegetation will be coordinated with MADCR, the Town of Edgartown, landowners, USACE subject matter experts during the development of the remedial action work plan to ensure the habitat is not detrimentally affected. Detection of munitions on land would be performed using digital detection instrumentation such as the EM61-MK2 that employs TDEMI technology. Positioning for the digital instrumentation would be conducted using a GPS. These technologies are anticipated to be viable based on MRS-specific munitions and physical characteristics and successful past use at the MRS during the RI. Anomalies would be reacquired using a robotic total station. Intrusive activities would be performed using both mechanized equipment and hand-tools and restoration of disturbed areas would be required. Mechanized equipment will be used to remove the dunes in the vicinity of the rocket targets and in areas of high anomaly densities. Rocket motor bodies, due to their size, can be reliably detected to 4 ft bgs however, if anomalies are detected below a dug anomaly, they will be investigated, removed, and properly disposed of.

Because sensitive species are known to exist within the MRS, this alternative will require coordination with MA NHESP, landowners, MADCR, the Town of Edgartown,, and USFWS. Coordination with USFWS will establish conditions for working in areas where federally listed species may be present. A rare plant and wildlife habitat evaluation will be conducted during development of the work plan in accordance with MA NHESP guidelines. Fieldwork would be

scheduled to avoid sensitive species as much as possible. In addition, biological monitoring during the remedial action and habitat restoration, would be required as mitigation measures.

Unavoidable adverse impacts to vegetation would occur as a result of this alternative and would require site restoration in areas where vegetation was cleared. Detailed restoration activities would be presented in the remedial action work plan and coordinated with resource agencies.

Ocean: Due to the dynamic nature of the ocean surf zone, a "Mag and Dig" technique will be used for ocean clearance activities. Divers will identify anomalies on transects using underwater hand-held analog instruments, and subsequently excavate each anomaly as it is found. Rocket motor bodies, due to their size, can be reliably detected to 4 ft bgs however, if anomalies are detected below a dug anomaly, they will be investigated, removed, and properly disposed of.

Common activities for all MRS areas:

Any MPPEH recovered during the clearance would be BIP or consolidated for disposal. The MDAS would be consolidated during removal, certified as explosive-free MDAS, and disposed off-site for recycling.

After all clearance operations are complete, a review of the site will be made (similar to a CERCLA Five-Year Review) that will ensure the effectiveness of the remedial actions for UU/UE.

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FIGURE 5-2

Alternate 4: Subsurface Clearance, Former South Beach Moving Target Machine Gun and Katama Rocket Range MRS, Martha's Vineyard, MA

0 1,250 2,500 3,750 5,000 6,250 Feet	0 200 400 600 800 1,000 Meters	04/13/2015	Rev:	Drawn: JBO	Chk: DMS	SBeach_Alt_4_FS.mxd	PROJ: 562910000

5.5.2 Evaluation

Effectiveness: This alternative would be highly effective. The RAO of protecting the public at the MRS from explosive hazards associated with handling munitions encountered during residential, construction/maintenance, and recreational activities performed at ground surface and in subsurface soil would be achieved with a moderate degree of certainty through removal of munitions from the MRS . While this alternative uses proven and reliable technologies that will permanently remove the munitions hazard from the site, the dynamic nature of the surf zone prevents effective detection of all anomalies.

Implementability: The implementability of Alternative 4 is considered moderate. This alternative can be readily implemented and resources and equipment are available. Specialized equipment and personnel with specialized training will be required to successfully implement a subsurface clearance and some vegetation clearance will be required. In addition, subsurface clearance activities within water present some technical difficulties due to the dynamic nature of the water and reduced visibility underwater.

Relative Cost: The cost of conducting a subsurface clearance across the entire MRS is considered high (>$5M).

Summary: Since this alternative would be highly effective in achieving the RAO and reducing the hazards associated with munitions, this alternative will be retained for detailed analysis.

5.6 Screening of Potential Remedial Alternatives

The results of the initial screening of potential remedial alternatives assembled for the Former South Beach Moving Target Machine Gun and Katama Rocket Range MRS is presented in Table 5-1 using the three criteria of effectiveness, implementability, and cost. As a result of the screening, all of the alternatives were considered viable and were retained for further evaluation.

Table 5-1. Screening of Potential Remedial Alternatives for the Former South Beach Moving Target Machine Gun and Katama Rocket Range MRS

Alternative	Relative Effectiveness	Implementability	Relative Cost	Overall Viability[a]
Alternative 1: No DoD Action Indicated	Low	Easy	None	Required by NCP to be retained
Alternative 2: Land Use Controls	Moderate	Easy	Moderate	Moderate: Retained
Alternative 3: Land Area Only Subsurface Clearance with LUCs (309 Acres)	Moderate	Moderate	High	Moderate: Retained
Alternative 4: Complete subsurface clearance Land and Water (695 Acres)	High	Moderate	High	High: Retained

Note: [a] Overall viability primarily considers the relative effectiveness and implementability.

6.0 Detailed Analysis

The detailed analysis of alternatives consists of the analysis and presentation of the information needed to allow decision-makers to select a site remedy, not the decision-making process itself. During the detailed analysis, each alternative for the Former South Beach Moving Target Machine Gun and Katama Rocket Range MRS is assessed against the NCP evaluation criteria described in Subsection 6.1. The results of the detailed analysis are arrayed to compare the alternatives against each other to identify the remedial alternative that provides the best balance of benefits and costs. This detailed analysis approach is designed to provide decision-makers sufficient information to adequately compare the alternatives, to select an appropriate remedy for the MRS, and to demonstrate satisfaction of the CERCLA remedy selection requirements in the DD.

Based on the screening of potential alternatives for the Former South Beach Moving Target Machine Gun and Katama Rocket Range MRS (Table 5-1), the following alternatives will be evaluated in detail against the NCP criteria:

- Alternative 1 – No Action
- Alternative 2 – LUCs
- Alternative 3 – Land Area Only Subsurface Clearance with LUCs (309 Acres)
- Alternative 4 – Complete subsurface clearance Land and Water (695 Acres)

6.1 Evaluation Criteria

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

As described in the NCP, the following two "threshold criteria" must be met in order for the alternative to be considered further:

1. **Overall protectiveness of human health and the environment -** Determines whether an alternative achieves the RAO by eliminating, reducing, or controlling threats to public health and the environment through LUCs, engineering controls, or treatment. An emphasis is placed on effectiveness in terms of worker safety issues during remedial actions and post-remedial action for local residents and workers based on future land use.

2. **Compliance with ARARs -** Evaluates whether the alternative meets federal and state environmental statutes, regulations, and other requirements that pertain to the site, or whether a waiver is justified. The ARARs identified for the Former South Beach Moving Target Machine Gun and Katama Rocket Range MRS alternatives are summarized in Table 6-1.

Table 6-1. ARARs Identified for Former South Beach Moving Target Machine Gun and Katama Rocket Range MRS Alternatives

ARAR	Alternative 1 – No Action	Alternative 2 – LUCs	Alternative 3 – Land Area Only Subsurface Clearance with LUCs (309 Acres)	Alternative 4 –Complete Subsurface Clearance Land and Water (695 Acres)
16 U.S.C. §1538(a)(1)	x	x	✓	✓
40 CFR 264.601	x	x	✓	✓
321 CMR 10.04(1)	x	x	✓	✓
321 CMR 10.23(1)	x	x	✓	✓
321 CMR 10.23(2)	x	x	✓	✓
321 CMR 10.23(3)	x	x	✓	✓
321 CMR 10.23 (6) (b) (1)	x	x	✓	✓
321 CMR 10.23(6) (b) (2)	x	x	✓	✓
321 CMR 10.23(7) (a)	x	x	✓	✓
321 CMR 10.23(7) (b)	x	x	✓	✓
310 CMR 9.40 (2)(b) (1st sentence)	x	x	✓	✓
310 CMR 9.40 (3)(b) (1st sentence)	x	x	✓	✓
310 CMR 10.25 (5) Land under the Ocean	x	x	x	✓
310 CMR 10.25 (6) Land under the Ocean	x	x	x	✓
310 CMR 10.25 (7) Land under the Ocean	x	x	x	✓
310 CMR 10.27 (3) Coastal Beaches	x	x	✓	✓
310 CMR 10.27 (6) Coastal Beaches	x	x	✓	✓
310 CMR 10.27 (7) Coastal Beaches	x	x	✓	✓
310 CMR 10.28 (3) Coastal Dunes	x	x	✓	✓

ARAR	Alternative 1 – No Action	Alternative 2 – LUCs	Alternative 3 – Land Area Only Subsurface Clearance with LUCs (309 Acres)	Alternative 4 –Complete Subsurface Clearance Land and Water (695 Acres)
310 CMR 10.28 (6) Coastal Dunes	x	x	✓	✓
310 CMR 10.29 Barrier Beaches	x	x	✓	✓
310 CMR 10.32 (3) Salt Marshes	x	x	✓	✓
310 CMR 10.32 (6) Salt Marshes	x	x	✓	✓
314 CMR 9.06 (2)(1st sentence)	x	x	✓	✓
314 CMR 9.07 (1)(a)(1st sentence)	x	x	✓	✓

Notes: × Not Identified as ARAR for Alternative ✓ Identified as ARAR for Alternative

See Section 3.0 for further explanation of the specific provisions which are potential ARARs. No ARARs were identified associated with Alternatives 1 or 2. Table 6-1 identifies the ARARs for Alternatives 3 and 4 involving clearance activities.

The following five "balancing criteria" described below are weighed against each other and are the primary criteria upon which the detailed analysis is based:

3. **Long-term effectiveness and permanence -** Considers the ability of an alternative to maintain protection of human health and the environment over time. The evaluation of the long-term effectiveness and permanence of containment and controls takes into account the magnitude of residual risk, the adequacy of the alternative in limiting the risk, the need for long-term monitoring and management, and the administrative feasibility of maintaining the LUCs and the potential risk should they fail. The evaluation also considers mechanisms such as the CERCLA Five-Year Review process to assess on a periodic basis the long-term effectiveness and permanence, as well as the protectiveness, of the alternative.

4. **Reduction of toxicity, mobility, or volume (TMV) of contaminants through treatment -** Considers an alternative's use of treatment to reduce the harmful effects of principal contaminants, their ability to move in the environment, and the amount of contamination present.

5. **Short-term effectiveness -** Considers the length of time needed to implement an alternative and the risks the alternative poses to workers, residents, and the environment

during implementation. In addition, for MEC, safety considerations include an evaluation of what resources available and how long it will take to mitigate munitions hazards and achieve the RAO.

6. **Implementability -** Considers the technical and administrative feasibility of implementing the alternative, including factors such as the relative availability of goods and services, and the relative effort associated with implementation of the alternative.

7. **Cost -** Includes estimated capital costs. Costs provided in the Detailed Analysis section include Remedial Alternative Costs plus Five-Year Review Costs ($42,000 per review) to provide a meaningful comparison. However, Five-Year Review costs are calculated separately from the remedial alternative. Cost estimates are expected to be accurate within a range of +50% to -30% (EPA, 1988).

The last two criteria, the "modifying criteria," are usually evaluated following the receipt of comments on the FS, and thus are completed after the Proposed Plan and public comment period on the plan and are presented in the Decision Document:

8. **State acceptance -** Assesses the technical and administrative issues and concerns the state (Massachusetts Department of Environmental Protection) may have regarding each of the alternatives evaluated in this FS as well as the preferred alternative presented in the Proposed Plan. State acceptance of an alternative will be evaluated after the Proposed Plan is issued for public comment. Therefore, the state acceptance criterion is not considered in the FS.

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

6.2 Alternative 1 – No Action

The No Action alternative for the Former South Beach Moving Target Machine Gun and Katama Rocket Range MRS is evaluated relative to the NCP criteria as follows:

1. **Overall Protectiveness of Human Health and the Environment** – Alternative 1 would not be protective of human health and the environment. Munitions items remain within the MRS and a small risk for encountering MEC exists Based on the historical reports of munitions-related discoveries within the MRS and quantity of munitions estimated to remain, property owners and MRS users will likely continue to encounter munitions in the future which should be handled by qualified/trained personnel and managed

appropriately. Alternative 1 would not otherwise eliminate, reduce, or control the threat of human exposure to surface and subsurface munitions and potential for munitions to be handled by unqualified/untrained personnel.

2. **Compliance with ARARs -** There are no ARARs associated with Alternative 1.

3. **Long-Term Effectiveness and Permanence –** Alternative 1 is not expected to reduce the magnitude of risk over the long term based on intended future land use. Alternative 1 requires no technical components and poses no uncertainties regarding its performance.

4. **Reduction of TMV of Contaminants Through Treatment -** Alternative 1 would not reduce the toxicity, volume or mobility associated with the munitions hazards within the MRS.

5. **Short-Term Effectiveness –** There would be no additional risk to the community or site workers or the environment because there are no construction or operation activities associated with Alternative 1, and it would require no time to complete.

6. **Implementability –** Alternative 1 is considered easily implementable. It poses no technical difficulties and no coordination with other agencies would be required.

7. **Cost -** The total cost to perform Alternative 1 is $0.

6.3 Alternative 2 – Land Use Controls

Alternative 2 – LUCs for the Former South Beach Moving Target Machine Gun and Katama Rocket Range MRS is evaluated relative to the NCP criteria as follows:

1. **Overall Protectiveness of Human Health and the Environment -** Alternative 2 would be protective since it controls exposure through LUCs. Munitions items remain within the MRS and a small risk for encountering MEC exists. Based on the historical reports of munitions-related discoveries within the MRS and quantity of munitions estimated to remain, property owners and MRS users will likely continue to encounter munitions in the future which should be handled by qualified/trained personnel and managed appropriately. Alternative 2 would eliminate, reduce, or control the threat of human exposure to surface and subsurface munitions and potential for munitions to be handled by unqualified/untrained personnel.

2. **Compliance with ARARs -** There are no ARARs associated with Alternative 2.

3. **Long-Term Effectiveness and Permanence –** Alternative 2 would provide effectiveness through LUCs as long as the LUCs remain in place. The results of the Institutional Analysis (Appendix B) indicate that local governmental agencies and one private landowner would be willing to provide support to distribute information. The remedial

design will specify the individual informational materials and educational programs that will be used to manage risk. The LUC components for risk management include printed informational materials such as signs, brochures, fact sheets, providing awareness training materials to the local authorities , and 3Rs protocol to be followed if munitions are encountered in the future. Awareness training materials will be provided to the local authorities to

Maintaining the LUCs in the long term is required. If the LUC components fail, there would be a risk of untrained personnel handling munitions when encountered. LUC enforcement (i.e., awareness training and review and reproduction of informational materials), periodic inspections (at least annually) and maintenance (i.e., installed signs) would be conducted to ensure that LUCs remain effective and that the land use has not changed. Reviews would also be conducted once every 5 years as required by CERCLA to determine if the remedy is or will be protective of human health and the environment.

4. **Reduction of TMV of Contaminants Through Treatment** – Alternative 2 does not involve treatment.

5. **Short-Term Effectiveness -** There would be no additional risk to workers, residents or the environment because there are no construction intrusive activities associated with Alternative 2. Approximately 6 months would be required to establish LUCs associated with Alternative 2.

6. **Implementability -** The LUC components recommended in Alternative 2 can be readily implemented. There are no technical difficulties associated with this alternative, and the materials and services needed to implement this alternative are available. Printed informational materials and training materials (media-based) can be readily developed and disseminated by support from local government agencies (Appendix B).

7. **Cost -** The total cost to perform Alternative 2 is $621,000. This cost has been rounded to the nearest thousand dollars. The cost estimate for Alternative 2 is provided in Appendix C.

   This alternative would require Five-Year Reviews to be conducted. These costs are not part of the remedy but are included in the alternative cost above for an effective comparison of alternatives. Each Five-Year Review is estimated to be $42,000.

6.4 Alternative 3 – Land Area Only Subsurface Clearance with LUCs (309 Acres)

Alternative 3 – Land Area Only Subsurface Clearance with LUCs (309 Acres) is evaluated relative to the NCP criteria for the Former South Beach Moving Target Machine Gun and Katama Rocket Range MRS as follows:

1. **Overall Protectiveness of Human Health and the Environment** - Munitions items remain within the MRS and a small risk for encountering MEC exists. Based on the historical reports of munitions-related discoveries within the MRS and quantity of munitions estimated to remain, property owners and MRS users will likely continue to encounter munitions in the future, which should be handled by qualified/trained personnel and managed appropriately.

   Clearance of munitions at ground surface and in the subsurface over 309 acres under Alternative 3 is conceptualized to remove all remaining munitions estimated to remain in the MRS, to reduce the probably of humans encountering munitions in the future at the MRS to the greatest extent possible. Therefore, a surface and subsurface clearance throughout the entire MRS (excluding under existing homes, paved roadways/driveways) would provide protectiveness of human health by fully eliminating, reducing, and controlling threats to protect human health.

   Alternative 3 would provide protection to human health by reducing the volume of munitions that may be potentially mishandled or disposed of improperly when encountered at the beach and land portions of the MRS that are currently accessible. The residual munitions from the ocean would be managed through the implementation of LUC components similar to Alternative 2.

2. **Compliance with ARARs –** Twenty two ARARs were identified for the Tisbury Great Pond MRS Alternative 3 (See Table 6-1). Alternative 3 would comply with all ARARs and procedures for ensuring compliance would be developed in the Remedial Action Work Plan. Clearance of MEC (including using a consolidated shot approach is needed) would be performed to fulfill all DoD and EPA guidance for munitions response and explosives safety. Work would also be conducted to comply with 16 U.S.C. §1538(a)(1) and 321 CMR 10.04 (1) by avoiding impacts to threatened and endangered species. Procedures for ensuring compliance would be developed in the Remedial Design/Remedial Action Work Plans.

3. **Long-Term Effectiveness and Permanence -** Clearance of munitions on the land and beach portions of the MRS would provide some long-term effectiveness, but the bulk of potentially remaining munitions are likely to be in the ocean and would be left in-place. The munitions in the ocean could be transported to the beach via wave action. LUC components would provide additional long-term effectiveness and permanence by assisting in managing risk before, during, and after the clearance activity. Alternative 3 would provide long-term effectiveness primarily through the implementation of LUC components, but also to limited extent through the removal of munitions on beach and land. If the LUC components fail, there would be a potential risk of untrained/unqualified

personnel handling munitions when encountered. LTM for LUC enforcement, inspections and maintenance would be same as Alternative 2.

LUC enforcement (i.e., awareness training and review and reproduction of informational materials), periodic inspections (at least annually) and maintenance (i.e., installed signs) would be conducted to ensure that LUCs remain effective and that the land use has not changed. The results of the Institutional Analysis (Appendix B) indicate that local governmental agencies and one private landowner would be willing to provide support to distribute information. Reviews would also be conducted once every 5 years as required by CERCLA to determine if the remedy is or will be protective of human health and the environment.

4. **Reduction of TMV of Contaminants Through Treatment -** Clearance would fully eliminate the TMV of MEC in a portion of the MRS. Alternative 3 would not fully eliminate MEC since only a portion of the MRS would undergo clearance.

5. **Short-Term Effectiveness –**Impacts to local residents and the public may occur, but would be temporary and limited to the immediate work area. Small equipment or material staging areas may be required, but could be constructed within each work area or one designated area within the MRS. Vegetation clearing would be required. Large-scale disturbance of topsoil and vegetation will increase surface water runoff and the effects of wind erosion. Extensive restoration will be required with a very long duration of time required for complete recovery of vegetated covering. Procedures for minimizing, reducing or mitigating negative effects would be developed in the Remedial Design/Remedial Action Work Plans. LUC components would not increase risk to workers or the public as described in Alternative 2. It is estimated that surface clearance under Alternative 3 with LUCs would require approximately 6 months to implement.

6. **Implementability -** Subsurface clearance of MEC is technically and administratively feasible and can be implemented at the MRS, as demonstrated during the RI. Materials and services to perform Alternative 3 are readily available. Coordination with MADEP, MA NHESP, MADCR, the Town of Edgartown and TTOR is required for this alternative. The LUC components recommended in Alternative 3 can be readily implemented. There are no technical difficulties associated with this alternative, and the materials and services needed to implement this alternative are available. Printed informational materials and training materials (media-based) can be readily developed and disseminated by support from local government agencies (Appendix B).

7. **Cost**—The total cost to perform Alternative 3 at the Former South Beach Moving Target Machine Gun and Katama Rocket Range MRS is $8,885,000. The cost estimate for Alternative 3 is provided in Appendix C.

This alternative would require Five-Year Reviews to be conducted. These costs are not part of the remedy bur are included in the alternative cost above for an effective comparison of alternatives. Each Five-Year Review is estimated to be $42,000.

6.5 Alternative 4 –Complete Subsurface Clearance Land and Water (695 Acres)

Alternative 4 –Complete Subsurface Clearance Land and Water (695 Acres) is evaluated relative to the NCP criteria for the Former South Beach Moving Target Machine Gun and Katama Rocket Range MRS as follows:

1. **Overall Protectiveness of Human Health and the Environment** - Munitions items remain within the MRS and a small risk for encountering MEC exists. Based on the historical reports of munitions-related discoveries within the MRS and quantity of munitions estimated to remain, property owners and MRS users will likely continue to encounter munitions in the future, which should be handled by qualified/trained personnel and managed appropriately.

   Alternative 4 would provide protection to human health by reducing the volume of munitions that may be encountered in the land, beach, and ocean subsurface up to 3 feet bgs where interaction by all potential receptors is most likely both now and potentially in the future.

2. **Compliance with ARARs –** Twenty five ARARs were identified for the Tisbury Great Pond MRS Alternative 3 (See Table 6-1). Alternative 3 would comply with all ARARs and procedures for ensuring compliance would be developed in the Remedial Action Work Plan. Clearance of MEC (including using a consolidated shot approach is needed) would be performed to fulfill all DoD and EPA guidance for munitions response and explosives safety. Work would also be conducted to comply with 16 U.S.C. §1538(a)(1) and 321 CMR 10.04 (1) by avoiding impacts to threatened and endangered species. Procedures for ensuring compliance would be developed in the Remedial Design/Remedial Action Work Plans.

3. **Long-Term Effectiveness and Permanence** - Clearance of munitions within the entire MRS would provide long-term effectiveness by permanently removing munitions from the MRS. Alternative 4 would provide long-term effectiveness through the permanent removal of all remaining munitions without relying on LUCs and/or LTM to maintain the effectiveness of the alternative following implementation. After all clearance operations are complete, a review of the site will be made (similar to a CERCLA Five-Year Review) that will ensure the effectiveness of the remedial actions for UU/UE.

4. **Reduction of TMV of Contaminants Through Treatment -** Any recovered MPPEH or suspect MEC that is discovered with MD during the clearance would be rendered MDAS on-site prior to certification for off-site disposal via recycling.

5. **Short-Term Effectiveness –**Impacts to local residents and the public may occur, and extend beyond the immediate work area. Significant equipment and material staging areas would be required to support diving and excavation activities, and would need to be established along the periphery of the work area to allow access. Vegetation clearing would be required. Large-scale disturbance of topsoil and vegetation will increase surface water runoff and the effects of wind erosion. Extensive restoration will be required with a long duration of time required for complete recovery of vegetated covering. Environmental impacts and impacts to the public may occur during BIP activities in the unlikely event that MPPEH or suspect MEC is discovered that is consolidated for venting or BIP. Procedures for minimizing, reducing, or mitigating negative effects would be developed in the Remedial Design/Remedial Action Work Plans. It is estimated that subsurface clearance under Alternative 4 would require approximately 2 years to implement.

6. **Implementability** - Subsurface clearance of munitions is technically and administratively feasible and can be implemented at the Former South Beach Moving Target Machine Gun and Katama Rocket Range MRS, as demonstrated during the RI. Materials and services to perform Alternative 4 are readily available. Coordination with MADEP, MA NHESP and TTOR is required for this alternative . Right-of-Entry agreements would be needed to access and work within the MRS.

7. **Cost**—The total cost to perform Alternative 4 at the MRS is $16,048,000. The cost estimate for Alternative 4 is provided in Appendix C.

6.6 Comparative Analysis of Remedial Alternatives

Based on the detailed analysis of remedial alternatives, the strengths and weaknesses of the remedial alternatives relative to one another are evaluated with respect to each of the NCP criteria below.

1. **Overall Protectiveness of Human Health and the Environment –** Munitions items remain within the MRS and a small risk for encountering MEC exists. Based on the historical reports of munitions-related discoveries within the MRS and quantity of munitions estimated to remain, property owners and MRS users will likely continue to encounter munitions in the future, which should be handled by qualified/trained personnel and managed appropriately. Alternative 1 would not eliminate, reduce, or control the threat of human exposure to surface and subsurface munitions and potential

for munitions to be handled by unqualified/untrained personnel and disposed of improperly. Alternative 2 would be protective but only controls exposure through LUCs. Alternative 3 provides protectiveness as munitions may be removed from beach and land; however, RI characterization identified most MD within the ocean (the current location of the historic targets). Alternative 4 is protective of human health because subsurface munitions would be destroyed from the entirety of the MRS. Risks to the environment associated with Alternative 4 are greatest and would require extensive planning, management, monitoring of endangered and threatened species, and restoration.

2. **Compliance with ARARs -** There are no regulations or criteria associated with Alternative 1 or Alternative 2, and Alternatives 3 and 4 would be implemented and performed to comply with all ARARs. Alternative 3 would require less coordination and planning to avoid potential environmental impacts than Alternative 4 since there is no ocean subsurface clearance included in Alternative 3. Alternative 4 would be intrusive in nature and would require attention to impacts on marine environmental resources.

3. **Long-Term Effectiveness and Permanence -** Alternative 1 is not effective or permanent. Alternative 2 would be effective since it controls exposure through LUCs. However, it relies on exposure control rather than removal or treatment. Under Alternative 3, all munitions would be destroyed within the land and beach portions of the MRS, but would still require LUCs in the long-term. Alternative 4 would remove MEC hazards from within the entirety of the MRSs and would be effective and permanent remedial alternative over the long-term because it would eliminate risk regardless of the future use of the property.

4. **Reduction of TMV of Contaminants Through Treatment -** Alternatives 1 and 2 would not reduce the TMV of munitions within the MRS. Alternative 3 would be effective in the reduction of TMV through destruction of all munitions within the land and beach portions of the MRS. Alternative 4 would be effective in reducing the TMV of munitions because all detectable MEC throughout the entirety of the MRS would be destroyed.

5. **Short-Term Effectiveness -** Because no construction activities are associated with either alternative, Alternatives 1 and 2 would not present significant additional risk to the public or workers at the MRS. Alternatives 3 and 4 would increase risk to the public and workers during clearance of munitions to variable degrees based on the implementation of exclusion zones for intrusive activities and in cases where MPPEH or suspect MEC is encountered requiring treatment on-site to render the item MDAS. Alternatives 1 and 2 would not cause damage to the environment because no clearing, grubbing, or excavation would be required. Alternatives 3 and 4 would cause some damage to the environment because of the excavation required to conduct beach subsurface activities. The time

durations required to complete Alternative 2 is estimated at 6 months. Alternatives 3 and 4 would require 1 year and 2 years respectively to complete the field work.

6. **Implementability –** Alternative 1 would be easily implemented. The LUCs recommended as Alternative 2 could also be readily implemented because these activities pose no technical difficulties and the materials and services needed are readily available. Clearance of munitions to various depths, similar to the actions proposed in Alternatives 3 and 4 were implemented effectively at the Former South Beach Moving Target Machine Gun and Katama Rocket Range MRS during the RI; however, these alternatives are more difficult to implement than Alternative 2. Alternative 4 would take longer to implement than Alternative 3 as it would be performed over a large area and would require intrusive ocean work. Alternative 4 would be slightly more difficult to implement because of the additional administrative work required as a result of the length of the clearance compared to Alternative 3. Specific activities, including awareness training for workers and use of protection procedures/mitigation techniques would be required to preserve and restore environmental resources during any of the clearance alternatives.

7. **Cost—**The total cost to perform each alternative is as follows:

   - Alternative 1 = $0
   - Alternative 2 = $369,000 + $42,000 x 6 (Five-Year Reviews) = $621,000
   - Alternative 3 = $8,634,000 + $42,000 x 6 (Five-Year Reviews) = $8,885,000
   - Alternative 4 = $16,006,000 + $42,000 x 6 (Five-Year Reviews) = $16,048,000

   Note: Costs have been rounded to the nearest thousand dollars.

Table 6-1 presents the comparative summary of the detailed analysis of the alternatives for the Former South Beach Moving Target Machine Gun and Katama Rocket Range MRS.

Table 6-2 Comparative Summary of Detailed Analysis of Remedial Alternatives

Former Moving Target Machine Gun and Katama Rocket Range Alternatives					
Evaluation Criteria		Alternative 1: No Action	Alternative 2: LUCs	Alternative 3: Partial Subsurface Clearance with LUCs	Alternative 4: Complete Subsurface Clearance Land and Water – 695 Acres
Threshold	1. Overall Protection of Human Health and Environment	■	●	●	●
	2. Compliance with ARARs	●	●	●	●
Balancing	3. Long-Term Effectiveness	■	□	□	●
	4. Reduction of TMV through Treatment	■	■	□	●
	5. Short-Term Effectiveness	●	●	□	□
	6. Implementability	●	●	□	□
	7. Cost[1]	$0	$621,000	$8,885,000	$16,048,000
Modifying[2]	8. State Acceptance	TBD	TBD	TBD	TBD
	9. Community Acceptance	TBD	TBD	TBD	TBD

Notes: [1] Costs are detailed in Appendix C. Costs provided here include review costs plus remedial action costs ($42,000 per review) are required for Alternatives 2 and 3.
[2] The modifying criteria will be evaluated after the Proposed Plan following review and input from these parties.
TBD = to be determined

● Favorable (Pass for threshold criteria)
□ Moderately Favorable
■ Not Favorable (Fail for threshold criteria)

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7.0 References

Code of Federal Regulations (CFR), Title 40 – *Protection of Environment,* Volume 28, Chapter I, Part 300 – *National Oil And Hazardous Substances Pollution Contingency Plan*.

Department of the Army (Army), 1989. *After Action Report – Ordnance Clearance Operation on Martha's Vineyard, MA; 14 March 1989 – 12 May 1989*. May

Department of Defense (DoD), 2012. DoD Manual Number 4715.20, *Defense Environmental Restoration Program Management*. March 9.

Martha's Vineyard Chamber of Commerce. http://www.mvy.com/visitor_information/frequently asked_questions.aspx. Accessed 2/15/2012.

Massachusetts Natural Heritage Endangered Species Program (MA NHESP), 2008. *Massachusetts Natural Heritage Atlas 13th Edition*. October.

Massachusetts Division of Fisheries & Wildlife (MDFW). 2012. BioMap2, Conserving the Biodiversity of Massachusetts in a Changing World: West Tisbury. Natural Heritage and Endangered Species Program.
http://maps.massgis.state.ma.us/dfg/biomap/pdf/town_core/West%20Tisbury.pdf

USACE, 2008. *Finding and Determination of Eligibility, South Beach at Martha's Vineyard (Moving Target Machine Gun Range), FUDS Property Number D01MA0486, Edgartown, Massachusetts*. July

USACE, 2009. Cape Poge Little Neck Bomb Target Site Preliminary Assessment, February.

USACE, 1999. *Final, Archives Search Report for the former Tisbury Great Pond, Martha's Vineyard Massachusetts*. November.

USACE, 2000. Engineering Pamphlet (EP) 1110-1-24, *Establishing And Maintaining Institutional Controls For Ordnance And Explosives (OE) Projects*. December.

USACE, 2006. EP 1110-1-18, *Military Munitions Response Process*. April.

USAEC (U.S. Army Environmental Command). 2009. *Final Military Munitions Response Program, Munitions Response Remedial Investigation/Feasibility Study Guidance*. November.

United States Army and Engineering Center, Huntsville (USAECH), 2010. *Explosives Site Plan, Correction 1, Remedial Investigation/Feasibility Study, Former Cape Poge Little Neck Bomb Target Site, Former Moving Target Machine Gun Range, Tisbury Great Pond, Martha's Vineyard, Massachusetts, D01MA0595*. September.

United States Department of Natural Resources-Soil Conservation Service (USDA-SCS), 1986. *Soil Survey of Dukes County, Massachusetts*. September.

United States Environmental Protection Agency (USEPA), 1988. Interim Final *Guidance for Conducting Remedial Investigation and Feasibility Studies Under CERCLA*. October.

United States Fish and Wildlife Service (USFWS), 1991. *Final Report, Northeast Coastal Areas Study: Significant Coastal Habitats of Southern New England and Portions of Long Island, New York.* August.

UXB International, Inc. (UXB), 2011. *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, Final*. September.

UXB, 2014. *Remedial Investigation Report, Former Moving Target Machine Gun Range at South Beach Area of Investigation, Final*. June.

UXB, 2012. UXB Form 02-06-2, Daily Report, Revision 1. March.

VRHabilis (VRH), 2008. South Beach Emergency Response Photographs. August.

VRH, 2009. One person response to potential ordnance items, Wasque Point, Chappaquiddick Island. February.

VRH, 2011. UXO Emergency Response, August 1

APPENDIX A: UPDATED CONCEPTUAL SITE MODEL

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Revised Conceptual Site Model Summary Former Moving Target Machine Gun Range at South Beach Investigation Area

Facility Profile	Physical Profile	Release Profile	Land Use and Exposure Profile	Ecological Profile
Facility Description: • Investigation Area is ~ 478 acres.(1) • FUDS boundary is 4,2014.85 acres • Located south of Edgartown along the southern edge of Martha's Vineyard, Massachusetts. • Historical structures used by the U.S. Navy on the site include a moving target machine gun range track, three former firing lines, a concrete storage area, and two rocket target areas (2) **Site History:** • Former Moving Target Machine Gun Range and Katama Rocket Range o The site was used from 1944 to 1947 by the Naval Air Station Quonset Point, Rhode Island for the purpose of a gunnery and rocket firing range. (2) o Rockets, bombs, and bomb fragments have been observed on the property. (2) • Wasque Point o On two occasions, 2008 and 2009, 100 lb bombs were discovered at Wasque Point. **Munitions Potentially Used:** • 0.30 and 0.50 caliber ammunition • MK 1 rockets • 2.25 in. to 5 in. rockets(1)	**Site Characteristics:** • Approximately 18.7 acres of land • Approximately 190.4 acres of beach • Approximately 268.7 acres of ocean • Due to extensive beach erosion, the former rocket targets are now approximately 150 yards seaward of South Beach. (1) The eastern end of the investigation area (Wasque Point) lost ~575 ft of land and beach within one year. (2009- 2010). **Topography:** • The site is relatively flat. • The beach portion of the site is dynamic with surf continuously eroding and depositing sand. (1) **Vegetation:** • Low grass vegetation. **Surface Water:** • Mattakeset Herring Creek, an intermittent stream, flows through the site between two former firing lines and the former moving target track. • 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. **Geology:** • Glacial deposits consisting of recent beach and marsh sediments, glacial deposits, interglacial deposits, and glacially deformed ancient coastal plain sediments (3). • Bedrock is encountered at approximately 500 ft below ground surface and is comprised of metamorphic and igneous rocks.(3) **Hydrogeology:** • Depth of groundwater ranges from 0 to greater than 6 ft bgs.(4) • Groundwater on Martha's Vineyard is primarily discharged directly to the ocean and surrounding bays. (3) **Meteorology:** • Average Annual Rainfall = 46 in. per year (3).	**Contaminants of Potential Concern:** • lead in soil **Media of Potential Concern:** • Surface soil, subsurface soil, and groundwater. **Confirmed MEC Locations:** o Historical evidence and RI results indicate there is no MEC associated with the Former Moving Target Machine Gun Range and Katama Rocket Range. Prior to the RI, two suspected 100 lb bombs, were reported at Wasque Point, however, there is no supporting evidence that they were the cause of historical operations at South Beach. **Confirmed Munitions Debris Locations:** o During the 1988-1989 unexploded ordnance removal action, 1,655 munitions debris items were successfully recovered with approximately 99 of those items being warheads.(5)During the 2009 Time-Critical Removal Action, 617 muniti[ons] debris items were identified and removed. Items included 2.25 to 5 in. sub-caliber aircraft rockets, 5 in. rocket warheads, 1 to 3.5 in. rocket warheads, 3 to 3.25 in. rockets with warheads, and 3 to 3.25 in. rockets with 5 in. warheads. o During the 2010-2011 Remedial Investigation, nature and extent of MD was delineated. 0 MEC items and 98 MD items were recovered. Recovered items included practice rockets. These items were concentrated in the ocean near the target areas and to the east. **MC Results:** • Former Moving Target Machine Gun Range o During the 2010-2011 RI, surface soil, subsurface soil, and groundwater samples were collected within the area of the former firing lines and impact berms. Sample results indicate that MC concentrations do not exceed human health screening criteria. Lead was detected in soil samples at concentrations exceeding ecological screening criteria. **Identified Pathways:** • Former Moving Target Machine Gun Range and Katama Rocket Range o Lead 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. o MD items are transported by various physical factors/transport processes that include ocean currents; natural erosion of soil by wind and water exposing buried MD items; and, removal or relocation by the public.	**Current Landowners:** • South Beach is owned and managed by the Commonwealth of Massachusetts, Department of Conservation and Recreation (MADCR), and managed by the Edgartown Parks and Recreation Department from the first of May through Labor Day of each year. (1) • Private landowners in the vicinity of the former Moving Target Machine Gun Range firing lines and suspected impact berm occupy small portions of the property. (1) **Current Land Use:** • The former range encompasses an area that is currently a public beach used for recreational purposes such as hiking, canoeing, kayaking, fishing, clamming, crabbing, wildlife observation, photography, education, and other water related activities. (1) • The northern portion of the site is developed with single-family residential homes, and asphalt roads. **Future Land Use:** • Land use is not expected to change in the future. **Potential Receptors:** • Potential receptors associated with current and future land use include residents, recreation users, onsite workers, and biota. • There is concern for public safety due to munitions items washing onto the shore at South Beach. (1)	**Property Description:** • The former site consists of uplands that contain residential and commercial development, a small strip of beach, and the Atlantic Ocean. • The primary use of the property is residential use and recreational use, with a moderate degree of disturbance. **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) • Avoidance techniques were used during the field investigation to minimize the potential for encountering threatened or endangered species. No threatened or endangered species were observed during the field work at the Investigation Area. **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, 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.
(3) 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.
(4) United States Department of Natural Resources-Soil Conservation Service (USDA-SCS), 1986. *Soil Survey of Dukes County, Massachusetts*. September.
(5) Department of the Army, 1989. *After Action Report – Ordnance Clearance Operation on Martha's Vineyard, MA; 14 March 1989 – 12 May 1989*. May.

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APPENDIX B: INSTITUTIONAL ANALYSIS

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March 2015

INSTITUTIONAL ANALYSIS REPORT

FORMER MACHINE GUN AND KATAMA ROCKET RANGE
MUNITIONS RESPONSE SITE
MARTHA'S VINEYARD, MASSACHUSETTS

FUDS Property No. D01MA0453
Contract No. W912DY-04-D-0019
Task Order No. 0006

U. S. ARMY CORPS OF ENGINEERS
NEW ENGLAND DISTRICT

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ACRONYMS

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
DERP	Defense Environmental Restoration Program
DoD	Department of Defense
EP	Engineer Pamphlet
ER	Engineer Regulation
EPA	U.S. Environmental Protection Agency
FS	feasibility study
FUDS	Formerly Used Defense Site
IC	institutional control
LUC	land use control
MADEP	Massachusetts Department of Environmental Protection
MEC	munitions and explosives of concern
MMRP	Military Munitions Response Program
MRA	munitions response area
MRS	munitions response site
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
TPP	Technical Project Planning
TTOR	The Trustees of Reservations
USACE	U.S. Army Corps of Engineers
USAEC	U.S. Army Environmental Command
U.S.	United States
USC	United States Code

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1.0 PURPOSE OF THE STUDY

This Institutional Analysis identifies and analyzes the institutional framework necessary to support the development of an effective land use control (LUC) response action alternative for the Former Machine Gun and Katama Rocket Range Munitions Response Site (MRS), located within the Former Machine Gun and Katama Rocket Range Munitions Response Area (MRA). The MRS and MRA are Formerly Used Defense Site (FUDS) Property Number D01MA048600R1, located on Martha's Vineyard, Massachusetts. The purpose of this report is to document the information collected from Institutional Analysis Questionnaires which were distributed to determine the stakeholders having jurisdiction over the MRS and to access the capability and willingness of these entities to assert LUCs that would protect the public from any hazards potentially present associated with munitions and explosives of concern (MEC) within the limits of the MRS.

The Feasibility Study (FS) was performed in support of the Department of Defense (DoD) Military Munitions Response Program (MMRP). UXB International, Inc. was authorized to conduct the FS through a United States Army Engineering Support Center, Huntsville Contract, No. W912DY-04-D-0019, Task Order No. 006.

2.0 METHODOLOGY

Two types of general response actions are typically considered for remedial action at munitions response sites for comparison to a baseline condition of "no action":

- **Risk Management** - Risk Management, which is considered a "limited" action alternative by the U.S. Environmental Protection Agency (EPA), includes various LUC options that rely on legal mechanisms, engineering controls, or administrative functions to control access or to modify human behavior and provide long-term management of risk.
- **Removal Action** - Remaining munitions can be detected and removed from the ground surface and/or below the ground surface. Alternatives for munitions clearance include technologies for detection, positioning for the detection technologies, removal, and disposal.

In accordance with the FUDS program guidance, the term LUCs encompasses physical, legal, or administrative mechanisms that restrict the use of, or limit access to, contaminated property to reduce risk to human health and the environment. Physical mechanisms encompass a variety of engineered remedies to contain or reduce contamination and physical barriers to limit access to property, such as fences or signs. The legal mechanisms are generally the same as those used for institutional controls (ICs) as discussed in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). ICs are a subset of LUCs and are primarily legal mechanisms imposed

to ensure the continued effectiveness of land use restrictions imposed as part of a remedial decision. Legal mechanisms include restrictive covenants, negative easements, equitable servitudes, and deed notices. Administrative mechanisms, which can also be ICs, include notices, adopted local land use plans and ordinances, educational programs, construction permitting, or other existing land use management systems that may be used to ensure compliance with use restrictions. Educational programs can include a variety of types of information dissemination and training that can be tailored to specifically address an identified hazard and exposed populations.

Development of LUC components considered for the MRSs referred to the United States Army Corps of Engineers (USACE) guidance Engineering Pamphlet (EP) 1110-1-24 for Establishing and Maintaining Institutional Controls for Ordnance and Explosive Projects (USACE, 2000). The main objective is to design controls that rely on legal mechanisms, physical barriers or warnings, or administrative mechanisms such as construction support or educational components to restrict access or modify human behavior to reduce exposure risks. LUCs should be managed and maintained at the local level whenever possible. For FUDS properties, property owners or state and local government agencies with appropriate authorities (i.e., zoning boards) are often the best candidates for LUC management and enforcement (USACE, 2004). Effectiveness of LUCs is dependent on coordination and willingness to participate in maintenance and enforcement by all stakeholders for the duration that the specific control applies to the MRS.

The methodology used to evaluate potential LUCs focused on reducing the potential for handling munitions at the MRS and included a review of the government and non-government entities that have some form of jurisdiction or ownership of the properties within the MRS. Data was collected from site documentation, public records, discussions with the project stakeholders at Technical Project Planning (TPP) sessions, and through the development of questionnaires sent to all stakeholders. Once jurisdiction and ownership were determined, information concerning these entities was reviewed, including:

- capabilities;
- resources; and,
- willingness to participate.

During the review of current and future capabilities of ICs, current and future land use and public safety resources were considered. The review and analysis focused on identifying potential controls that could be included in a comprehensive risk management strategy for the Tisbury Great Pond MRS to support the FS effort.

3.0 SCOPE OF EFFORT

The Institutional Analysis was prepared in accordance with United States (U.S.) Army guidance,

including MMRP document, *Final Military Munitions Response Program, Munitions Response Remedial Investigation/Feasibility Study Guidance* [U.S. Army Environmental Command (USAEC), 2009], and EP 1110-1-24, *Establishing and Maintaining Institutional Controls for Ordnance and Explosives Projects* (USACE, 2000). The scope of effort for the Institutional Analysis is to collect information and document which stakeholder entities have jurisdiction over the Former Machine Gun and Katama Rocket Range MRS; defines authority, responsibility, capability, resources, and the willingness of each entity to participate in ICs to protect the public from explosive hazards; identifies potential strategies available to implement access control and public safety awareness actions for the property; and, defines and analyzes intergovernmental relationships, joint responsibilities, LUC functions, technical capabilities, funding sources, and recommendations.

4.0 SELECTION CRITERIA

Based on relevance to the IC process for the MRS, the following agencies and organizations were selected for the Institutional Analysis including:

1. Department of the Army;
2. Massachusetts Department of Environmental Protection (MADEP);
3. Massachusetts Department of Conservation and Recreation (MADCR);
4. Dukes County;
5. The Trustees of Reservations (TTOR);
6. Town of Edgartown, Massachusetts;
7. Sheriff's Meadow Foundation;
8. Stanmar, Inc.
9. Katama Shores Condominium Trust;
10. Mr. and Mrs. Steven L. Ablon;
11. Mr. David M. Baum;
12. Mr. David M. Brush;
13. Mr. and Mrs. Robert N. Cohen;
14. Mr. and Mrs. Raymond J. Drop;
15. Ms. Mary Melissa Previdi;
16. Mr. Ronald L. Sargent;
17. Mr. Kenneth Schiciano;
18. Mr. and Mrs. Richard P. Schifter; and,
19. Mr. John D. Sims.

Criteria used to identify these entities included: known jurisdiction as a public agency; authority to assist in implementation; responsibility for the control of land use; known willingness/ability to assist; land ownership; and, known resources and capability to provide public information or education for awareness activities.

Department of the Army: The Army is the executive agent for the FUDS program, and USACE is the program's executing agent. USACE is the lead agency providing technical oversight and project management with funding for response actions requested through the Environmental Restoration-FUDS account at the MRS. USACE must comply with the Defense Environmental Restoration Program (DERP) statute [10 United States Code (USC) § 2701 et seq.], Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (42 USC § 9601 et seq.), Executive Orders 12580 and 13016, the NCP, and all applicable DoD [e.g., EP 1110-1-18 (USACE, 2006), Engineering Regulation (ER) 200-3-1 (USACE, 2004), DoD *Management Guidance for the DERP* (DoD, 2012)] and Army policies in managing and executing the FUDS program (USACE, 2004). Because the land within the MRS is not owned by the DoD, USACE has minimal control relative to implementing, maintaining, monitoring, or enforcing ICs.

Massachusetts Department of Environmental Protection: MADEP is the support agency providing regulatory support for remedial decision-making at the MRS. MADEP is the state agency responsible for ensuring clean air and water, the safe management of toxics and hazards, the recycling of solid and hazardous wastes, the timely cleanup of hazardous waste sites and spills, and the preservation of wetlands and coastal resources. MADEP has been fully engaged in the TPP process at the MRS and has provided guidance on all activities performed to date. Based on the response received from solicitations regarding willingness and capability to participate in LUCs at the MRS, MADEP indicated that the agency would be willing to distribute information provided by USACE and generally supports LUCs as part of a remedial alternative, but was not willing or capable to contribute to funding for LUCs.

Massachusetts Department of Conservation and Recreation: MADCR is a state agency that serves to protect, promote, and enhance cultural and recreational resources within the Commonwealth of Massachusetts. MADCR owns and manages South Beach, which encompasses portions of the former ranges as well as a small beach parcel on the western portion of Wasque Point. MADCR has been fully engaged in the TPP process at the MRS and has provided guidance on all activities performed to date. A completed questionnaire was not submitted.

Dukes County, Massachusetts: Dukes County officials and various departments have interest and involvement in the FUDS project, which were coordinated with throughout the project. Dukes County officials who may be solicited for information about the MRS have been made aware of the findings and progress of investigation at the MRS through presentations at TPP meetings and local responders have been alerted to munitions discovered at the MRS through the 911 system. Dukes County owns beach and inland waters from South Beach to Wasque Point. Based upon the response received, Dukes County is willing to reproduce information provided by USACE, issue and enforce land use permits, and supports LUCs as part of a remedial alternative. Dukes County is willing to contribute costs associated with the issuance and

enforcement of land use permits.

The Trustees of Reservations: TTOR is a non-profit land conservation and historic preservation organization dedicated to preserving natural and historical places in the Commonwealth of Massachusetts. TTOR owns and manages a 2.5-mile strip of beach and inland waters along Norton Point, which is in the central portion of the MRS. TTOR does not have local zoning or enforcement authority. Based on the response received from solicitations regarding willingness and capability to participate in LUCs at the MRS, TTOR indicated that the organization would be willing to produce copies of informational fact sheets/notices, allow for the installation of warning signs, distribute information provided by USACE to site workers, and supports LUCs as part of a remedial alternative, but was not willing or capable to contribute to funding for LUCs.

Town of Edgartown: The Town of Edgartown officials, responders, and various natural resource agencies have interest and involvement in the FUDS project, which were coordinated with throughout the project. Specifically, Edgartown officials who may be solicited for information about the MRS have been made aware of the findings and progress of investigation at the MRS through presentations at TPP meetings and local responders have been alerted to munitions discovered at the MRS through the 911 system. The Town of Edgartown is not accepting of LUCs as part of the remedial alternative and is not willing to participate in associated activities.

Sheriff's Meadow Foundation: The Sheriff's Meadow Foundation is an organization that seeks to conserve the natural, rural landscape of Martha's Vineyard. Currently, Sheriff's Meadow Foundation owns over 2,000 acres of conservation land, including Huckleberry Barrens located north of the MRS, and holds conservation restrictions on over 850 acres. The foundation does not have local zoning or enforcement authority. Based on the response received from solicitations regarding willingness and capability to participate in LUCs at the MRS, the Sheriff's Meadow Foundation indicated that the organization would be willing to reproduce and distribute copies of informational fact sheets/notices, allow for the installation of warning signs, distribute information provided by USACE to site workers, but was not willing or capable to contribute to funding for LUCs.

Stanmar, Inc.: No response was received.

Katama Shores Condominium Trust: No response was received.

Mr. and Mrs. Steven Ablon: The Ablon's are private landowners that own a parcel of land adjacent to South Beach within the MRS. Based upon the response received, the Ablon's are willing to distribute information provided by USACE and provide for the associated costs of reproducing and distributing information.

Mr. David M. Baum: Mr. Baum is a private landowner that owns a parcel of land adjacent to

South Beach within the MRS. Based upon the response received, Mr. Baum is not accepting of LUCs as part of the remedial alternative and is not willing to participate in associated activities.

Mr. David M. Brush: No response received.

Mr. and Mrs. Robert N. Cohen: The Cohen's are private landowners that own a parcel of land adjacent to South Beach within the MRS. Based upon the response received, the Cohen's are not accepting of LUCs as part of the remedial alternative and is not willing to participate in associated activities.

Mr. and Mrs. Raymond J. Drop: The Drop's are private landowners that own a parcel of land adjacent to South Beach within the MRS. Based upon the response received, the Drop's are not accepting of LUCs as part of the remedial alternative and is not willing to participate in associated activities.

Ms. Mary Melissa Previdi: Ms. Previdi is a private landowner that owns a parcel of land adjacent to South Beach within the MRS. Based upon the response received, Ms. Previdi is not accepting of LUCs as part of the remedial alternative and is not willing to participate in associated activities.

Mr. Ronald L. Sargent: No response received.

Mr. Kenneth Schiciano: Mr. Schiciano is a private landowner that owns a parcel of land adjacent to South Beach within the MRS. Based upon the response received, Mr. Schiciano is not accepting of LUCs as part of the remedial alternative and is not willing to participate in associated activities.

Mr. and Mrs. Richard P. Schifter: No response received.

Mr. John D. Sims: No response received.

5.0 ACCEPTANCE OF JOINT RESPONSIBILITY

The agencies and organizations listed in Section 4 have been involved in the investigation process through the use of TPP meetings, the securing of right-of-entry agreements, and the inclusion in report distribution for investigation findings for the MRS to date. The LUC components being contemplated in the FS are designed to provide a mechanism that affects human behavior to reduce the risk of encountering munitions remaining at the MRS. LUCs established for the MRS require landowner support to be effective. As indicated above, the public landowners (MADCR, Dukes County, TTOR, and the Town of Edgartown) responded to the questionnaire developed by USACE to facilitate the Institutional Analysis. Therefore, the willingness and capabilities of public landowners are known. Six of the twelve private landowners that received the questionnaire responded; therefore, the willingness and capabilities of private landowners are not fully known.

6.0 TECHNICAL CAPABILITY

Several private residences are located within the MRS. However, the technical capabilities of these residences to provide support for LUCs are unknown. Minimal technical capabilities are needed for MADCR, Dukes County, TTOR, and the Town of Edgartown, including officials and natural resource agencies, to provide specific awareness to the property users. USACE is technically capable of performing all other potential response actions, including support in the form of technical guidance to property owners should they pursue establishing legal mechanisms for their properties to address munitions.

7.0 INTERGOVERNMENTAL RELATIONSHIPS

USACE is the lead agency providing technical oversight and project management with funding for response actions requested through the Environmental Restoration FUDS account at the MRS. MADEP is the support agency for remedial decision-making at the MRS. Both agencies have worked successfully to perform investigation and response efforts to date. The public landowners (MADCR, Dukes County, TTOR, and the Town of Edgartown) have control and jurisdiction over the land within the MRS in accordance with land use, ordinance, and zoning rules for the Town of Edgartown.

8.0 STABILITY

The Town of Edgartown, USACE, MADEP, and MADCR are all considered stable institutions.

9.0 FUNDING SOURCES

Funding has been provided through the Army FUDS program. Additional funding will be required through the ER-FUDS account to implement a remedial alternative for the MRS. None of the organizations that responded to the questionnaire indicated that they would be willing or capable to fund IC components for the MRS as part of a remedial alternative.

10.0 RECOMMENDATIONS

There are no existing LUCs currently at the MRS. All project stakeholders will continue to be involved in the selection of a final remedy and implementation for the MRS in accordance with CERCLA and the NCP. In the FS, the following remedial action objective was established for the Former Machine Gun and Katama Rocket Range MRS: to protect recreational users, landowners, visitors, and workers at the MRS from explosive hazards associated with MEC exposure in the dunes and in the top 3 feet of subsurface soil during intrusive activities and by dune erosion. Informational materials and educational LUC components to provide awareness and affect human behavior have been identified that are either considered a remedial alternative themselves, or will support an active clearance option being contemplated in the FS.

Based on the results of the Institutional Analysis, USACE shall manage and execute

establishment of all LUC components, if any, included in the final remedy selected. Funding will be required through the ER-FUDS account to implement LUCs for the MRS. MADEP, MADCR, Dukes County, TTOR, the Town of Edgartown, the Sheriff's Meadow Foundation, and Mr. and Mrs. Steven Ablon are willing to provide support to distribute information provided by USACE. Of the organizations and landowners that responded to the questionnaire, only Dukes County and Mr. and Mrs. Steven Ablon are willing or capable to contribute to funding for LUCs.

11.0 REFERENCES

Code of Federal Regulations, Title 40 -*Protection of Environment,* Volume 28, Chapter I, Part 300-*National Oil And Hazardous Substances Pollution Contingency Plan.*

DoD (Department of Defense). 2012. *DoD Manual 4715.20, Defense Environmental Restoration Program (DERP) Management.* March 2012.

USACE (United States Army Corps of Engineers). 2000. Engineer Pamphlet 1110-1-24, *Establishing and Maintaining Institutional Controls for Ordnance and Explosives Projects.* December 2000.

USACE, 2004. Engineer Regulation 200-3-1, *Formerly Used Defenses Sites (FUDS) Program Policy.* May 2004.

USACE, 2006. Engineer Pamphlet 1110-1-18. *Military Munitions Response Process.* 3 April 2006.

USAEC (U.S. Army Environmental Command), 2009. *Final Military Munitions Response Program, Munitions Response Remedial Investigation/Feasibility Study Guidance.* October 2009.

United States Environmental Protection Agency (EPA), 1988. Interim Final *Guidance for Conducting Remedial Investigation and Feasibility Studies Under CERCLA.* October.

APPENDIX C: COST ESTIMATES

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South Beach MRS
Alternative 2
Land Use Controls

CAPITAL COST:

Bid Item No.	Description	QTY	Unit	Team Production (Units/Day)	# Teams	Duration (Weeks)	Weekly Cost Per Team	Cost Per Acre	Total
0100	Work and Safety Plans, UFP-QAPP, TPP	0.00	LS	N/A	N/A	N/A	$ 97,169	N/A	$ -
0110	Explosive Safety Submission	0.00	LS	N/A	N/A	N/A	$ 23,515	N/A	$ -
0200	Mobilization - Per Person	0.00	Person	N/A	N/A	N/A	$ 1,756	N/A	$ -
0300	Site Management	0.00	Week	1.00	1	0.00	$ 49,906	N/A	$ -
0310	Survey/Positioning	0.00	AC	10.00	1	0.00	$ 15,389	$ -	$ -
0320	Brush Clearing	0.00	AC	12.00	1	0.00	$ 2,865	$ -	$ -
0330	Environmental Monitoring and Coordination (Habitat Survey)	0.00	AC	15.00	1	0.00	$ 39,621	$ -	$ -
0400	MEC Surface Removal	0.00	AC	3.00	2	0.00	$ 43,586	$ -	$ -
0410	MEC Sub-surface Removal, Analogue	0.00	AC	2.00	1	0.00	$ 45,168	$ -	$ -
0420	Digital Geophysical Mapping	0.00	AC	3.00	1	0.00	$ 21,389	$ -	$ -
0430	Digital Data Analysis	0.00	AC	3.00	1	0.00	$ 9,164	$ -	$ -
0440	Anomaly Reacquisition	0.00	AC	2.00	2	0.00	$ 15,389	$ -	$ -
0450	Anomaly Resolution	0.00	AC	2.00	2	0.00	$ 45,168	$ -	$ -
0460	Dune MEC Removal - Sand Sifting	0.00	CY	450.00	3	0.00	$ 46,205	$ -	$ -
0500	Underwater MEC Removal - No Divers	0.00	AC	1.00	2	0.00	$ 45,685	$ -	$ -
0510	Underwater MEC Removal - Divers	0.00	AC	1.5	2	0.00	$ 86,667	$ -	$ -
0520	DGM - Underwater	0.00	AC	4.0	1	0.00	$ 25,099	$ -	$ -
0540	Anomaly Resolution - Underwater	0.00	AC	1.5	2	0.00	$ 86,667	$ -	$ -
0600	MDAS Certification and Disposal	0.00	LS	0.2	1	0.00	$ 19,545	N/A	$ -
0610	Site Restoration	0.00	LS	0.1	1	0.00	$ 36,159	N/A	$ -
0620	Demobilization	0.00	Person	N/A	N/A	N/A	$ 690	N/A	$ -
0700	Remedial Action Completion Report	0.00	LS	N/A	N/A	N/A	$ 78,598	N/A	$ -
0710	Land Use Control Plan	1.00	LS	N/A	N/A	N/A	$ 36,741	N/A	$ 36,741
0800	Land Use Control Implementation	1.00	LS	N/A	N/A	N/A	$ 94,328	N/A	$ 94,328
0810	Annual Post-Construction Revegetation Monitoring	0.00	Year	N/A	N/A	N/A	$ 27,695	N/A	$ -
	Sub-Total								$ 131,069
	Contingency	15%							$ 19,660
	Sub-Total								$ 150,729
	Infrastructure Improvements	2%							$ 3,015
	Project Management	5%							$ 7,536
	Remedial Design (USACE)	8%							$ 12,058
	Construction Management (USACE)	6%							$ 9,044
	Total Capital Cost								**$ 182,383**

LONG-TERM MANAGEMENT COST:

	Description	Year	QTY	Unit	Unit Cost	Total
900	Long-Term Management	1-30	30	EA	$ 5,408	$ 162,239
910	UXO On-call Support	1-30	0	EA	$ 10,422	$ -
	Sub-Total					$ 162,239
	Contingency	15%				$ 24,336
	Project Management	5%				$ 8,112
	Total Long-Term Management Cost					**$ 186,574**

ALTERNATIVE 2: TOTAL CAPITAL AND LONG-TERM MANAGEMENT COST: **$ 368,957**

PERIODIC COST:

	Description	Year	QTY	Unit	Unit Cost	Total
0820	Five Year Review (cost per review)	5	6	EA	$ 42,166	$ 252,999

**5 Year Review not included in total alternative cost estimate*

ALTERNATIVE 2: TOTAL REMEDIAL ALTERNATIVE COST PLUS REVIEW COST **$ 621,955**

Notes: AC = acres EA = each LS = lump sum N/A = not applicable WK = week

South Beach MRS
Alternative 3
Land Area Only Subsurface Clearance with Land Use Controls
309 Acres of Subsurface Clearance

COST:

Bid Item No.	Description	QTY	Unit	Team Production (Units/Day)	# Teams	Duration (Weeks)	Weekly Cost Per Team	Cost Per Acre	Total
0100	Work and Safety Plans, UFP-QAPP, TPP	1.00	LS	N/A	N/A	N/A	$ 97,169	N/A	$ 97,169
0110	Explosive Safety Submission	1.00	LS	N/A	N/A	N/A	$ 23,515	N/A	$ 23,515
0200	Mobilization - Per Person	35.00	Person	N/A	N/A	N/A	$ 1,756	N/A	$ 61,470
0300	Site Management	48.00	Week	1.00	1	48.00	$ 49,906	N/A	$ 2,395,500
0310	Survey/Positioning	309.00	AC	10.00	2	3.09	$ 15,389	$ 308	$ 95,107
0320	Brush Clearing	144.00	AC	4.00	2	3.60	$ 2,865	$ 2,865	$ 20,628
0330	Environmental Monitoring and Coordination (Habitat Survey)	1.00	LS	N/A	N/A	N/A	$ 39,621	N/A	$ 39,621
0400	MEC Surface Removal	0.00	AC	3.00	2	0.00	$ 43,586	$ -	$ -
0410	MEC Sub-surface Removal, Analog	0.00	AC	2.00	1	0.00	$ 45,168	$ -	$ -
0420	Digital Geophysical Mapping	309.00	AC	4.00	3	5.15	$ 21,389	$ 1,069	$ 330,458
0430	Digital Data Analysis	309.00	AC	2.50	4	6.18	$ 9,164	$ 733	$ 226,525
0440	Anomaly Reacquisition	309.00	AC	7.50	2	4.12	$ 15,389	$ 410	$ 126,809
0450	Anomaly Resolution	309.00	AC	7.00	3	2.94	$ 45,168	$ 1,291	$ 398,765
0460	Dune MEC Removal - Sand Sifting	93,000.00	CY	500.00	1	37.20	$ 46,205	$ 18	$ 1,718,814
0500	Underwater MEC Removal - No Divers	0.00	AC	1.00	3	0.00	$ 45,685	$ -	$ -
0510	Underwater MEC Removal - Divers	0.00	AC	1.5	3	0.00	$ 86,667	$ -	$ -
0520	DGM - Underwater	0.00	AC	4.0	1	0.00	$ 25,099	$ -	$ -
0540	Anomaly Resolution - Underwater	0.00	AC	1.5	3	0.00	$ 86,667	$ -	$ -
0600	MDAS Certification and Disposal	1.00	LS	0.2	1	1.00	$ 19,545	N/A	$ 19,545
0610	Site Restoration	1.00	LS	0.1	1	4.00	$ 36,159	$ 1,166	$ 144,637
0620	Demobilization	35.00	Person	N/A	N/A	N/A	$ 690	N/A	$ 24,158
0700	Remedial Action Completion Report	1.00	LS	N/A	N/A	N/A	$ 78,598	N/A	$ 78,598
0710	Land Use Control Plan	1.00	LS	N/A	N/A	N/A	$ 36,741	N/A	$ 36,741
0800	Land Use Control Implementation	1.00	LS	N/A	N/A	N/A	$ 94,328	N/A	$ 94,328
0810	Annual Post-Construction Revegetation Monitoring	5.00	Year	N/A	N/A	N/A	$ 27,695	N/A	$ 138,474
	Sub-Total								$ 6,070,862
	Contingency	15%							$ 910,629
	Sub-Total								$ 6,981,492
	Infrastructure Improvements	2%							$ 139,630
	Project Management	5%							$ 349,075
	Remedial Design (USACE)	8%							$ 558,519
	Construction Management (USACE)	6%							$ 418,890
	Total Cost								**$ 8,447,605**

LONG-TERM MANAGEMENT COST:

	Description	Year	QTY	Unit	Unit Cost	Total
900	Long-Term Management	1-30	30	EA	$ 5,408	$ 162,239
910	UXO On-call Support	1-30	0	EA	$ 10,422	$ -
	Sub-Total					$ 162,239
	Contingency	15%				$ 24,336
	Project Management	5%				$ 8,112
	Total Long-Term Management Cost				$ 5,408	**$ 186,574**
			0		$ 10,422	

ALTERNATIVE 3: TOTAL CAPITAL AND LONG-TERM MANAGEMENT COST: **$ 8,634,179**

PERIODIC COST:

	Description	Year	QTY	Unit	Unit Cost	Total
0820	Five Year Review (cost per review)	5	6	EA	$ 41,739	$ 250,434

ALTERNATIVE 3: TOTAL REMEDIAL ALTERNATIVE COST PLUS REVIEW COST **$ 8,884,613**

Notes: AC = acres EA = each LS = lump sum N/A = not applicable WK = week

South Beach MRS
Alternative 4
Complete Subsurface Clearance
695 Acres (land and water)

COST:

Bid Item No.	Description	QTY	Unit	Team Production (Units/Day)	# Teams	Duration (Weeks)	Weekly Cost Per Team	Cost Per Acre	Total
0100	Work and Safety Plans, UFP-QAPP, TPP	1.00	LS	N/A	N/A	N/A	$ 97,169	N/A	$ 97,169
0110	Explosive Safety Submission	1.00	LS	N/A	N/A	N/A	$ 23,515	N/A	$ 23,515
0200	Mobilization - Per Person	35.00	Person	N/A	N/A	N/A	$ 1,756	N/A	$ 61,470
0300	Site Management	68.00	Week	1.00	1	68.00	$ 49,906	N/A	$ 3,393,626
0310	Survey/Positioning	309.00	AC	10.00	2	3.09	$ 15,389	$ 308	$ 95,107
0320	Brush Clearing	144.00	AC	4.00	2	3.60	$ 2,865	$ 2,865	$ 20,628
0330	Environmental Monitoring and Coordination (Habitat Survey)	1.00	LS	N/A	N/A	N/A	$ 39,621	$ 39,621	$ 39,621
0400	MEC Surface Removal	0.00	AC	3.00	2	0.00	$ 43,586	$ -	$ -
0410	MEC Sub-surface Removal, Analog	0.00	AC	2.00	1	0.00	$ 45,168	$ -	$ -
0420	Digital Geophysical Mapping	309.00	AC	4.00	3	5.15	$ 21,389	$ 1,069	$ 330,458
0430	Digital Data Analysis	309.00	AC	2.50	4	6.18	$ 9,164	$ 733	$ 226,525
0440	Anomaly Reacquisition	309.00	AC	7.50	2	4.12	$ 15,389	$ 410	$ 126,809
0450	Anomaly Resolution	309.00	AC	7.00	3	2.94	$ 45,168	$ 1,291	$ 398,765
0460	Dune MEC Removal - Sand Sifting	93,000.00	CY	500.00	1	37.20	$ 46,205	$ 18	$ 1,718,814
0500	Underwater MEC Removal - No Divers	72.00	AC	1.00	3	4.80	$ 45,685	$ -	$ 657,865
0510	Underwater MEC Removal - Divers	200.00	AC	1.5	3	8.89	$ 86,667	$ -	$ 2,311,118
0520	DGM - Underwater	114.00	AC	4.0	1	5.70	$ 25,099	$ -	$ 143,065
0540	Anomaly Resolution - Underwater	114.00	AC	1.5	3	5.07	$ 86,667	$ -	$ 1,317,337
0600	MDAS Certification and Disposal	1.00	LS	0.2	1	1.00	$ 19,545	N/A	$ 19,545
0610	Site Restoration	1.00	LS	0.1	1	4.00	$ 36,159	$ 583	$ 144,637
0620	Demobilization	35.00	Person	N/A	N/A	N/A	$ 690	N/A	$ 24,158
0700	Remedial Action Completion Report	1.00	LS	N/A	N/A	N/A	$ 78,598	N/A	$ 78,598
0710	Land Use Control Plan	1.00	LS	N/A	N/A	N/A	$ 36,741	N/A	$ 36,741
0800	Land Use Control Implementation	1.00	LS	N/A	N/A	N/A	$ 94,328	N/A	$ 94,328
0810	Annual Post-Construction Revegetation Monitoring	5.00	Year	N/A	N/A	N/A	$ 27,695	N/A	$ 138,474
	Sub-Total								$ 11,498,373
	Contingency	15%							$ 1,724,756
	Sub-Total								$ 13,223,129
	Infrastructure Improvements	2%							$ 264,463
	Project Management	5%							$ 661,156
	Remedial Design (USACE)	8%							$ 1,057,850
	Construction Management (USACE)	6%							$ 793,388
	Total Cost								**$ 15,999,986**

LONG-TERM MANAGEMENT COST:

	Description	Year	QTY	Unit	Unit Cost	Total
900	Long-Term Management	1-4	1	EA	$ 5,408	$ 5,408
910	UXO On-call Support	1-4	0	EA	$ 10,422	$ -
	Sub-Total					$ 5,408
	Contingency	15%				$ 811
	Project Management	5%				$ 270
	Total Long-Term Management Cost					**$ 6,219**

ALTERNATIVE 4: TOTAL CAPITAL AND LONG-TERM MANAGEMENT COST: **$ 16,006,205**

PERIODIC COST:

	Description	Year	QTY	Unit	Unit Cost	Total
0820	Five Year Review (cost per review)	5	1	EA	$ 42,166	$ 42,166

ALTERNATIVE 4: TOTAL REMEDIAL ALTERNATIVE COST PLUS REVIEW COST **$ 16,048,371**

Notes: AC = acres EA = each LS = lump sum N/A = not applicable WK = week