

Final
Feasibility Study Report
UXO 1, Eastern Conservation Area

Former Vieques Naval Training Range
Vieques, Puerto Rico



Prepared for

Department of the Navy

Naval Facilities Engineering Command
ATLANTIC

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Prepared by

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UXO 1, Eastern Conservation Area**

**Former Vieques Naval Training Range (VNTR)
Vieques, Puerto Rico**

Contract Task Order 037

October 2012

Prepared for

**Department of the Navy
Naval Facilities Engineering Command
Atlantic**

Under the

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Contract N62470-08-D-1000**

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Virginia Beach, Virginia

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Acronyms and Abbreviations

ARAR	applicable or relevant and appropriate requirements
ATG	air-to-ground
bgs	below ground surface
BTU	British Thermal Unit
CCP	Comprehensive Conservation Plan
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CH ₄	methane
CLEAN	Comprehensive Long-term Environmental Action—Navy
CO ₂	carbon dioxide
CO ₂ e	carbon dioxide equivalents
COC	chemical of concern
COPC	chemical of potential concern
DGM	digital geophysical mapping
DOE	Department of Energy
DOI	Department of Interior
ECA	Eastern Conservation Area
EIS	Environmental Impact Statement
e.g.	for example
EMA	Eastern Maneuver Area
EQB	Environmental Quality Board
ERA	ecological risk assessment
ERP	Environmental Restoration Program
ES	Executive Summary
FFA	Federal Facilities Agreement
FS	Feasibility Study
GHG	greenhouse gas
GRA	general response action
HHRA	human health risk assessment
IC	institutional control
IR	Installation Restoration
LIA	Live Impact Area
LTM	long-term monitoring
LUC	land use control
MD	munitions debris
MEC	munitions and explosives of concern
MEC HA	munitions and explosives of concern hazard assessment
MOA	Memorandum of Agreement
µg/kg	micrograms per kilogram
mm	millimeter
MOV	Municipality of Vieques
MRA	Munitions Response Area

N ₂ O	nitrous oxide
NASD	Naval Ammunition Support Detachment
NAVFAC	Naval Facilities Engineering Command
NCP	National Contingency Plan
NOx	nitrogen
NPL	National Priorities List
NPV	net present value
NTCRA	non-time critical removal action
O&M	operation and maintenance
OB/OD	open burn/open detonation
PM	particulate matter
PRA	Preliminary Range Assessment
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
RRD	range-related debris
SARA	Superfund Amendments and Reauthorization Act
SIA	Surface Impact Area
SOx	sulfur
TBC	to-be-considered
TCRA	time-critical removal action
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
UXO	unexploded ordnance
VNTR	Vieques Naval Training Range

Executive Summary

This report presents the Feasibility Study for UXO 1, Eastern Conservation Area (ECA), located at the Former Vieques Naval Training Range, Vieques, Puerto Rico, to develop and evaluate remedial alternatives to mitigate unacceptable risks from exposure to munitions and explosives of concern and potential risks from exposure to potentially contaminated media.

UXO 1 is approximately 133 acres in size and was established as a conservation area in 1983 (**Figure ES-1**). In 2003, a Memorandum of Agreement (MOA) was signed by the Department of Navy (Navy) and Department of the Interior (DOI) to transfer the eastern end of Vieques, including Area UXO 1, to DOI and requiring the land to be administered as a wildlife refuge (Navy and DOI, 2003). The site is managed by U.S. Fish and Wildlife Service as part of the Vieques National Wildlife Refuge with no planned public access or groundwater use. UXO 1 was not known to have been used as a target area for munitions; however, the site is located adjacent to the Live Impact Area (LIA), where naval gunfire and air-to-ground training activities occurred from the 1970s to through 2003 and where open burning/open detonation (OB/OD) activities were conducted. The LIA generated an explosive safety arc that extended into the ECA. Munitions and explosives of concern (MEC) and other munitions-related material have been identified within UXO 1 and were most likely from munitions directed toward the LIA that missed their intended target or from OB/OD operations.

The Remedial Investigation (RI) identified potential explosive safety risks associated with MEC present at UXO 1. No unacceptable human health or ecological risks were identified from chemical contaminants based on current and planned site use. Because the potential for MEC to be present onsite will remain and changes in site use are not planned, other uses (e.g., residential) were not evaluated. Therefore, it was not necessary to evaluate other land uses (e.g., residential) nor the medium to which exposure will not be permitted (i.e., groundwater). To ensure these other land uses and/or exposures do not occur, land use controls (LUCs) will be necessary at UXO 1.

The following Remedial Action Objectives (RAOs) were developed to be protective of current and potential future receptors:

- Minimize the explosive safety risk associated with MEC by minimizing the potential for uncontrolled human contact with MEC potentially present in site soil and lagoon.
- Maintain land use that is consistent with the Memorandum of Agreement between the U.S. Department of Navy and U.S. Department of Interior concerning the Transfer of Department of Navy Properties on the Eastern End of Vieques Island (Navy and DOI, 2003) without further evaluation of site risks.

The following remedial alternatives were evaluated to meet the RAOs:

- Alternative 1—No Action
- Alternative 2—Land Use Controls (LUCs) and Limited MEC Removal
- Alternative 3—Subsurface MEC Removal and LUCs

Each remedial alternative was evaluated against seven National Contingency Plan (NCP) evaluation criteria; the remaining two (community acceptance and state/commonwealth acceptance) will be evaluated following the Proposed Plan public comment process. **Table ES-1** presents a detailed evaluation of each alternative based on each of the seven NCP criteria evaluated. **Table ES-2** presents a semi-quantitative comparative analysis for each remedial alternative relative to one another.

Based on the above evaluation process, Alternative 1 does not meet the threshold criterion of Overall Protection of Human Health and the Environment because it does not include land use controls to minimize the explosive safety risk associated with MEC by minimizing the potential for uncontrolled human exposure to MEC potentially present in site soil and lagoon or maintain land use consistent with the MOA (Navy and DOI). Therefore,

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NOTA: ESTE RESUMEN SE PRESENTA EN INGLÉS Y EN ESPAÑOL PARA LA CONVENIENCIA DEL LECTOR. SE HAN HECHO TODOS LOS ESFUERZOS PARA QUE LA TRADUCCIÓN SEA PRECISA EN LO MÁS RAZONABLEMENTE POSIBLE. SIN EMBARGO, LOS LECTORES DEBEN ESTAR AL TANTO QUE EL TEXTO EN INGLÉS ES LA VERSIÓN OFICIAL.

Alternative 1 is not further discussed. Alternatives 2 and 3 both meet the threshold criteria. The Long-Term Effectiveness and Permanence for Alternatives 2 and 3 is relatively similar because each includes adequate and reliable controls. Alternative 3 performs slightly better due to the reduction in residual risk through site-wide subsurface MEC removal. Similarly, the extensive subsurface MEC removal results in a higher degree of Reduction in Toxicity, Mobility, and Volume for Alternative 3 than for Alternative 2. The Short-term Effectiveness of Alternative 2 is much greater than Alternative 3 because Alternative 3 includes significant environmental impacts due to vegetation clearing and ground disturbance and has a greater potential danger to site workers during implementation. Alternatives 2 and 3 are similarly implemental from an administrative standpoint. However, Alternative 2 could be more easily implemented than Alternative 3 because it would require much less intrusive activities. The present value cost of Alternative 2 (\$2.1 million) is approximately 20% of the estimated present value cost of Alternative 3 (\$10.5 million) based on a +50%/-30% range of accuracy.

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Resumen Ejecutivo

Este informe presenta el Estudio de Factibilidad para UXO 1, Área de Conservación del Este (ECA por sus siglas en inglés), ubicado en el antiguo Campo de Adiestramiento Naval de Vieques, Puerto Rico, para desarrollar y evaluar alternativas de remediación para mitigar los riesgos no aceptables relacionados a la exposición a municiones y explosivos de preocupación y los riesgos potenciales por la exposición a medios potencialmente contaminados.

UXO 1 tiene un tamaño aproximado de 133 acres y fue establecido como un área de conservación en 1983 (**Figura ES-1**). En el año 2003, se firmó un Memorando de Acuerdo (MOA por sus siglas en inglés) entre el Departamento de la Marina (Marina) y el Departamento del Interior (DOI) para la transferencia del lado este de Vieques a DOI, incluyendo el Área UXO 1, que requiere que los terrenos sean administrados como un refugio de vida silvestre (Navy and DOI, 2003). El Servicio de Pesca y Vida Silvestre de los EE.UU administra el sitio como parte del Refugio Nacional de Vida Silvestre de Vieques donde no se planifica abrir el sitio al público o usar el agua subterránea. No se conoce que UXO 1 haya sido utilizado como un área de práctica con municiones; sin embargo, el sitio está junto al Área de Impacto con Bala Viva (LIA por sus siglas en inglés), donde se realizaron prácticas de adiestramiento con armas navales de aire a tierra desde los años 1970s hasta el año 2003, y donde se llevaron a cabo actividades de quema abierta/detonación abierta (OB/OD por sus siglas en inglés). El LIA generó un arco de seguridad debido a los explosivos que se extendía hasta el ECA. Municiones y explosivos de preocupación (MEC por sus siglas en inglés) y otros materiales relacionado a municiones ha sido identificado dentro de UXO 1, que probablemente provienen de municiones dirigidas hacia el LIA y que no llegaron al blanco o de las operaciones OB/OD.

La Investigación para la Remediación (RI por sus siglas en inglés) identificó riesgos potenciales a la seguridad causados por los explosivos asociados con los MEC que se encuentran en UXO 1. En base a los usos actuales y planificados para el sitio, no se identificaron riesgos no aceptables para la salud humana, o riesgos ecológicos provenientes de contaminantes químicos. Debido a que todavía existe el potencial de que MEC estén presentes en el sitio y no se planifica cambiar el uso del sitio, no se evaluaron otros usos. Por lo que no fue necesario evaluar otros usos de los terrenos (ej. un uso residencial), tampoco el medio al que no se permitirá contacto (exposición) (ej. agua subterránea). Para asegurar que éstos y otros usos de los terrenos y/o exposiciones no ocurran, será necesario implementar controles de usos de los terrenos (LUCs por sus siglas en inglés) en UXO 1.

Se desarrollaron los siguientes Objetivos de la Acción de Remediación (RAOs por sus siglas en inglés) para proteger receptores potenciales actuales y futuros:

- Minimizar el riesgo de seguridad relacionado a explosivos asociado con los MEC al minimizar el potencial de contacto no controlado de personas con MEC que potencialmente pudieran estar presentes en el suelo del sitio y la laguna.
- Mantener el uso de los terrenos siguiendo el Memorando de Acuerdo, entre la Marina de los EE.UU y el Departamento del Interior de los EE.UU relacionado a la Transferencia de Propiedades de la Marina en el Extremo Este de la Isla de Vieques (Navy and DOI, 2003) sin que se evalúen más los riesgos del sitio.

Para cumplir con los RAOs se evaluaron las siguientes alternativas de remediación:

- Alternativa 1—No Acción
- Alternativa 2—Control de Uso de los Terrenos (LUCs por sus siglas en inglés) y Remoción Limitada de MEC
- Alternativa 3—Remoción de MEC debajo de la Superficie y LUCs

Cada alternativa de remediación fue evaluada contra siete de los nueve criterios de evaluación del Plan Nacional de Contingencia (NCP por sus siglas en inglés); los dos restantes (aceptación de la comunidad/y aceptación del estado/estado libre asociado) serán evaluados después del proceso de comentario público del Plan Propuesto. La **Tabla ES-1** presenta los detalles de la evaluación de cada alternativa en base a cada uno de los siete criterios NCP

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evaluados. La **Tabla ES-2** presenta un análisis comparativo semi-cuantitativo de cada alternativa de remediación, una con respecto a otra.

En base al proceso de evaluación arriba mencionado, la Alternativa 1 no cumple con el criterio mínimo (umbral) de Protección Total a la Salud Humana y el Ambiente ya que no incluye controles de uso de los terrenos para minimizar el riesgo relacionado a explosivos asociados con MEC al reducir al mínimo el potencial de exposición no controlada a MEC que potencialmente pudieran estar en los suelos del sitio y en la laguna, o mantener un uso de los terrenos siguiendo el MOA (Marina y DOI). Por lo que, la Alternativa 1 no será discutida de aquí en adelante. Las Alternativas 2 y 3 cumplen con el criterio umbral. La Efectividad a Largo Plazo y Permanencia de las Alternativas 2 y 3 son relativamente similares debido a que cada una incluye controles adecuados y confiables. El rendimiento de la Alternativa 3 es un tanto mejor debido a la reducción del riesgo residual a través de la remoción de MEC debajo de la superficie de todo el sitio. De igual manera, la remoción extensa de MEC debajo de la superficie produce un nivel más alto de Reducción de Toxicidad, Movilidad, y Volumen para la Alternativa 3 en comparación con la Alternativa 2. La Efectividad a Corto Plazo de la Alternativa 2 es mucho mayor que la Alternativa 3 ya que la Alternativa 3 incluye impactos ambientales significativos debido al corte de la vegetación y la perturbación del terreno, además tiene un potencial de peligro más alto para los trabajadores durante su implementación. Desde el punto de vista administrativo, las Alternativas 2 y 3 pueden implementarse de manera similar. Sin embargo, la Alternativa 2 puede implementarse más fácilmente porque requiere de menos actividades intrusivas. El costo actual de la Alternativa 2 (\$2.1 millones) es aproximadamente 20% menos en comparación con la Alternativa 3 (\$10.5 millones) en base a un rango de precisión de +50%/-30%.

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TABLE ES-1

Detailed Evaluation of Remedial Alternatives

Feasibility Study Report

UXO 1, Eastern Conservation Area

Former Vieques Naval Training Range

Vieques, Puerto Rico

Evaluation Criteria	Alternative 1	Alternative 2	Alternative 3
	No Action	LUCs and Limited MEC Removal	Subsurface MEC Removal and LUCs
Overall Protection to Human Health and the Environment			
Minimize the explosive safety risk associated with MEC by minimizing the potential for uncontrolled human contact with MEC potentially present in site soil and lagoon, and maintain land use that is consistent with the Memorandum of Agreement between the U.S. Department of Defense Properties on the Eastern End of Vieques Island.	This alternative would not meet the RAOs. Potential for human contact with MEC was significantly reduced because MEC were removed from areas with the greatest potential for exposure during interim removal actions. However, MEC are assumed to remain on site and this alternative includes no means to control access to the site, and thereby minimize uncontrolled human contact with remaining MEC. The alternative also does not include a means to confirm land use remains consistent with the Memorandum of Agreement.	This alternative would meet the RAOs because, in addition to the minimized potential for uncontrolled human contact with MEC resulting from the previous interim removal actions, it would implement LUCs to control site access, limit intrusive activities to prevent future uncontrolled human exposure, and maintain land use consistent with the Memorandum of Agreement. Unauthorized access to the site would be minimized by fencing, signage, ICs, and LTM.	This alternative would meet the RAOs because it would remove MEC that could reasonably be encountered based on the planned future site use plus implement LUCs to control site access, limit intrusive activities to minimize future uncontrolled human exposure, and maintain land use consistent with the Memorandum of Agreement. Subsurface MEC removal would reduce exposure risks across the site. Unauthorized access to the site would be minimized by fencing, signage, ICs, and LTM.
Compliance with ARARs			
Location-specific ARARs	Would comply with ARARs.	Would comply with ARARs.	Would comply with ARARs.
Action-specific ARARs	Not applicable. No action-specific ARARs.	Would comply with ARARs.	Would comply with ARARs.
Chemical-specific ARARs	Not applicable. No chemical-specific ARARs.	Not applicable. No chemical-specific ARARs.	Not applicable. No chemical-specific ARARs.
Long-Term Effectiveness and Permanence			
Magnitude of residual risks	No action would be taken; however, a significant reduction in risk already resulted from interim removal actions. Residual risks remain, but are present in areas with low likelihood of being encountered.	A significant reduction in risk already resulted from interim removal actions. Residual risks remain but would be reduced by minimizing uncontrolled human exposure to MEC and potentially contaminated media that may pose potentially unacceptable risk by LUCs, and implementing LTM to confirm their effectiveness and identify changes in site conditions.	Overall risk would be minimized by controlling exposure to MEC and potentially contaminated media that may pose potentially unacceptable risk by LUCs. Marginal additional risk reduction would occur through clearance of subsurface MEC across the site, as areas with highest likelihood of access (roads and beaches) have already been cleared.
Adequacy and reliability of controls	Access to the site is partially restricted, but LUCs to restrict access and activities are not in place and effectiveness is unknown because a monitoring program is not performed.	LUCs would reliably minimize the potential for uncontrolled human exposure to MEC and uncontrolled human contact with media that may pose unacceptable risk, and monitoring will be performed to confirm their effectiveness and identify changes in site conditions.	LUC would reliably minimize the potential for uncontrolled human exposure to MEC and human contact with potentially contaminated media that may pose potentially unacceptable risk, and monitoring would be performed to confirm their effectiveness and identify changes in site conditions.
Need for 5-year review	Because MEC remains in place, 5-year reviews would be required to evaluate the protectiveness of existing conditions.	Because MEC remains in place, 5-year reviews would be required to periodically evaluate the effectiveness and protectiveness of the remedy.	Because of the potential for MEC to remain even after the remedial action, 5-year reviews would be required to periodically evaluate the effectiveness and protectiveness of the remedy.

TABLE ES-1

Detailed Evaluation of Remedial Alternatives

Feasibility Study Report

UXO 1, Eastern Conservation Area

Former Vieques Naval Training Range

Vieques, Puerto Rico

Evaluation Criteria	Alternative 1	Alternative 2	Alternative 3
	No Action	LUCs and Limited MEC Removal	Subsurface MEC Removal and LUCs
Reduction of Toxicity, Mobility, or Volume Through Treatment			
Reduction of toxicity, mobility, or volume through treatment	No additional active remediation. Removal of MEC most likely to be encountered has already been conducted; remaining MEC would remain in place.	Limited additional active remediation. Removal and treatment (detonation) of MEC most likely to be encountered has already been conducted; remaining MEC would be removed and treated (detonation) only if identified during site inspections or if clearance of additional access pathways is necessary.	Reduction of MEC volume through removal and treatment (detonation) of subsurface MEC (down to 2 feet bgs) from the entire accessible area of site not previously addressed through the TCRA or NTCRA.
Short-Term Effectiveness			
Protection of community during remedial actions	None.	No community is located near the area where LUCs would be installed. Minimal impact to the community from traffic to transport materials to the site.	No community is located near the area where LUCs would be installed or where the subsurface removal would occur. Minimal impact to the community from traffic to transport materials and equipment to the site.
Protection of workers during remedial actions	None.	LUCs would likely require administrative resources and local co-operation. Fence and signage installation could be easily constructed with normal health and safety procedures and MEC avoidance. Limited MEC removal would follow well-established health and safety plan and procedures, with on-site UXO support, so that potential impacts to workers would be minimized.	LUCs would likely require administrative resources and local co-operation. The MEC clearance would follow well-established health and safety plan and procedure, with UXO on-site support, so that potential impacts to workers including explosive hazard, noise, and residue dust from munitions detonated would be minimized but are inherent.
Environmental impacts	None.	Minimal environmental impact due to vegetation clearing for fence installation. However, selection of the fence alignment will factor in clearing requirements, and vegetation will be allowed to regrow.	Significant temporary disturbance of land would occur during construction activities (i.e., vegetation clearance, MEC clearance, lagoon dewatering, erosion control, and re-vegetation. Lagoon habitat will be impacted but has demonstrated a tolerance to drastic changes in water level and is expected to become naturally restored).
Time until RAOs are achieved	Not achieved.	Approximately 6 months to control of risks with implementation of LUCs and LTM.	Approximately 1 year of planning and 1 year for completion of MEC clearance activities after completion of planning. Approximately 6 months to control of risks due to implementation of LUCs and LTM.
Environmental Footprint (In terms of greenhouse gas [GHG] emissions and energy consumption)	Low. (Estimated 8 metric tons GHG)	Medium. (Estimated 143 metric tons GHG)	High. (Estimated 252 metric tons GHG)

TABLE ES-1

Detailed Evaluation of Remedial Alternatives

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Vieques, Puerto Rico

Evaluation Criteria	Alternative 1	Alternative 2	Alternative 3
	No Action	LUCs and Limited MEC Removal	Subsurface MEC Removal and LUCs
Implementability			
Technical feasibility	No technical issues.	Services and materials are available and easily implementable.	Significant technical challenge for lagoon dewatering and vegetation clearance.
Administrative feasibility	Agency approval more involved. Unlikely to achieve administrative acceptance.	Feasible.	Feasible. Would likely involve substantive erosion control requirements (best management practices) due to disturbance of land.
Availability of services, equipment, and materials	None required.	Readily available.	Readily available.
Cost			
(See Table 4-2 for Cost Breakdown)	Low.	Moderately low.	Extremely High.

TABLE ES-2

Comparative Analysis of Remedial Alternatives

Feasibility Study Report

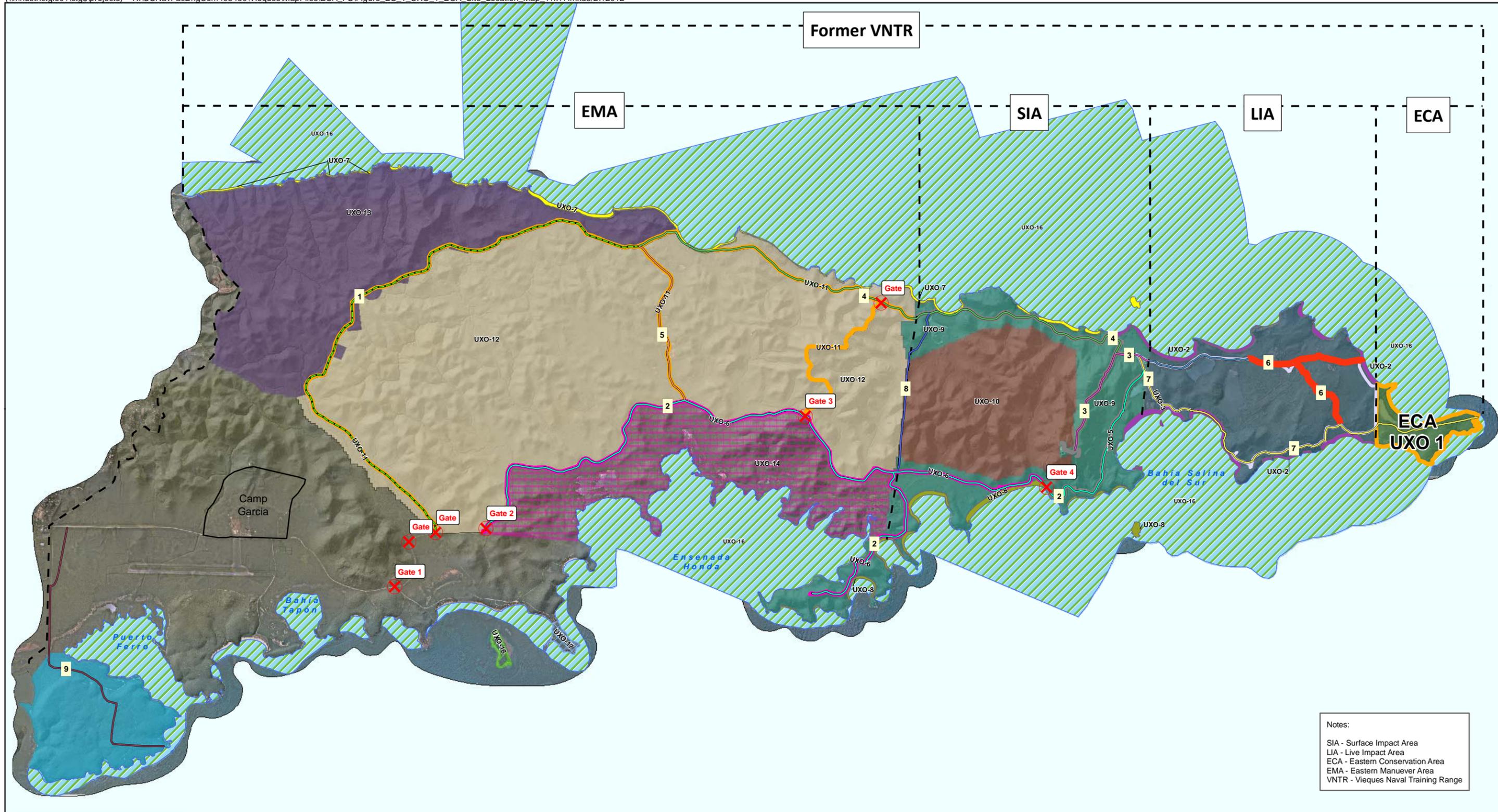
UXO 1, Eastern Conservation Area

Former Vieques Naval Training Range

Vieques, Puerto Rico

Criterion	Alternative 1	Alternative 2	Alternative 3
	No Action	LUCs and Limited MEC Removal	Subsurface MEC Removal and LUCs
Threshold Criterion			
Overall protection of human health and the environment	○	●	●
Compliance with ARARs	●	●	●
Compliance with Chemical-Specific ARARs	●	●	●
Compliance with Action-Specific ARARs	●	●	●
Compliance with Location-Specific ARARs	●	●	●
Balancing Criterion			
Long-term effectiveness and permanence	◐	◑	●
Magnitude of Residual Risk	◑	◑	●
Adequacy and Reliability of Controls	○	●	●
Reduction of toxicity, mobility, or volume through treatment	○	◑	●
Treatment Process Used and Materials Treated	○	●	●
Amount of Hazardous Materials Destroyed or Treated	Not Applicable	◑	●
Degree of Expected Reductions in Toxicity, Mobility, and Volume	Not Applicable	◑	●
Degree to Which Treatment is Irreversible	Not Applicable	●	●
Type and Quantity of Residual Remaining After Treatment	Not Applicable	◑	●
Short-term effectiveness	◑	◑	◐
Protection of Community During Remedial Actions	●	●	●
Protection of Workers During Remedial Actions	●	◑	◐
Environmental Impacts	●	◑	◐
Time Until Remedial Action Objectives are Achieved	○	●	◑
Implementability	◑	●	◐
Technical Feasibility	●	●	◐
Administrative Feasibility	○	●	●
Availability of Services, Equipment, and Materials	●	●	◐
Cost (Total Present Value)	\$ 184,000	\$ 2,078,000	\$ 10,546,000

Individual criterion scores: ○ not met ◐ poor ◑ satisfactory ● good ● excellent



Notes:
 SIA - Surface Impact Area
 LIA - Live Impact Area
 ECA - Eastern Conservation Area
 EMA - Eastern Maneuver Area
 VNTN - Vieques Naval Training Range

- | | | | |
|---|---|---|---|
| <ul style="list-style-type: none"> Gates UXO Escort Required Camp Garcia UXO 1 Boundary | <p>Authorized Access for Qualified Personnel Munitions Response Sites</p> <ul style="list-style-type: none"> 1 - EMA Range Access Road 2 - Range Access Road 3 - OP-1 Road 4 - North Shore Road 5 - EMA Connector Road 6 - North Road 7 - South Road 8 - SIA Boundary Road 9 - Puerto Ferro Road | <ul style="list-style-type: none"> UXO 1 - ECA UXO 2 - LIA Beaches UXO 3 - LIA Roads UXO 4 - LIA Interior UXO 5 - SIA Restricted Roads UXO 6 - EMA/SIA Public Roads UXO 7 - EMA/SIA North Beaches UXO 8 - SIA South Beaches | <ul style="list-style-type: none"> UXO 9 - SIA Exterior UXO 10 - SIA Interior UXO 11 - EMA Public Roads UXO 12 - EMA Interior UXO 13 - EMA West UXO 14 - EMA South UXO 15 - Puerto Ferro UXO 16 - Underwater Areas UXO 17 - PAOC EE UXO 18 - Cayo de la Chiva |
|---|---|---|---|

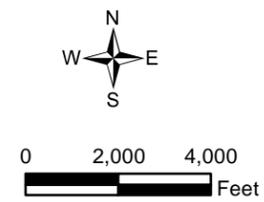


Figure ES-1
Site Location Map
 Feasibility Study Report
 UXO 1, Eastern Conservation Area
 Former Vieques Naval Training Range
 Vieques, Puerto Rico

Introduction

This report presents the Feasibility Study (FS) for UXO 1, Eastern Conservation Area (ECA), located at the Former Vieques Naval Training Range (VNTR), Vieques, Puerto Rico. This report was prepared under the U.S. Navy, Naval Facilities Engineering Command (NAVFAC) Atlantic Comprehensive Long-term Environmental Action-Navy (CLEAN) 1000, Contract N62470-08-D-1000, Contract Task Order 37, for submittal to NAVFAC, the U.S. Environmental Protection Agency (USEPA) Region 2, the Commonwealth of Puerto Rico Environmental Quality Board (EQB), and the United States Fish and Wildlife Service (USFWS). NAVFAC, USEPA, EQB, and USFWS work jointly as the Vieques Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Environmental Restoration Program (ERP) Technical Subcommittee.

The FS was performed in accordance with the process outlined in the Navy's ERP, which is consistent with the National Contingency Plan (NCP) and Section 120 of CERCLA as amended by the Superfund Amendments and Reauthorization Act (SARA). This FS was prepared in general accordance with the following guidance documents:

- *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (USEPA, 1988)
- *Guidance for Optimizing Remedy Evaluation, Selection, and Design* (NAVFAC, 2010)
- *Consideration of Green and Sustainable Remediation Practices in the Defense Environmental Restoration Program* (United States Department of Defense, 2009)

1.1 Objectives and Scope

Previous investigations have identified potential explosive safety risks associated with munitions and explosives of concern (MEC) present at UXO 1. The nature and extent of contamination, human health risk assessment (HHRA), ecological risk assessment (ERA), and MEC hazard assessment (MEC HA) are documented in the UXO 1 Remedial Investigation (RI) Report (CH2M HILL, 2012). The objectives of this FS are to develop remedial action objectives (RAOs), identify applicable or relevant and appropriate requirements (ARARs) and to-be-considered (TBC) criteria that may affect the remedy selection at UXO 1, and develop and evaluate remedial alternatives to mitigate risks from exposure to MEC at UXO 1 in accordance with current and anticipated land use. The information presented herein will be used by the ERP Technical Subcommittee to propose a remedial alternative that complies with the requirements of CERCLA and the NCP.

1.2 Site Background

This subsection provides a general summary of the Former VNTR and UXO 1 including site descriptions, environmental history, and previous investigations and actions.

1.2.1 Former Vieques Naval Training Range

Vieques is located in the Caribbean Sea approximately 7 miles southeast of the eastern tip of the island of Puerto Rico and 20 miles southwest of St. Thomas, U.S. Virgin Islands. It is approximately 20 miles long and 4.5 miles wide, and has an area of approximately 33,088 acres (51 square miles). **Figure 1-1** presents the location of Vieques with respect to the island of Puerto Rico.

The Navy purchased large portions of Vieques in the early 1940s to conduct activities related to military training. The eastern end of Vieques (i.e., VNTR) was used for various aspects of naval gunfire training, including air-to-ground ordnance delivery and amphibious landings, as well as housing the main base of operations for these activities, Camp Garcia. Site operations on the western end of Vieques, within the former Naval Ammunition Support Detachment (NASD), consisted mainly of ammunition loading and storage, vehicle and facility maintenance, and some training. The Navy ceased operations on the former NASD and VNTR prior to transferring the land to the Department of Interior (DOI), Municipality of Vieques (MOV), and the Puerto Rico Conservation Trust, as required by the Floyd D. Spence National Defense Authorization Act for Fiscal Year 2001 (Public Law 106-

398), which was amended by Section 1049 of the National Defense Authorization Act for Fiscal Year 2002 (Public Law 107-107). The NASD was transferred in May 2001 and the VNTR was transferred in May 2003.

On February 11, 2005, Vieques was placed on the National Priority List (NPL) as part of the former Atlantic Fleet Weapons Training Area - Vieques, which required all subsequent environmental restoration activities for Navy Installation Restoration (IR) sites on Vieques be conducted under CERCLA unless and until removed from CERCLA authority. The Navy, DOI, USEPA, and EQB executed a Federal Facility Agreement (FFA) on September 7, 2007, that established the procedural framework and schedule for implementing the CERCLA response actions for Vieques. Although the DOI is directed to protect and conserve the land transferred to it as part of the National Wildlife Refuge System, the Navy retains the responsibility for conducting environmental clean-up of the property, as warranted.

The former VNTR consists of approximately 14,600 acres and is divided into four separate operational areas that from west to east comprise: the 11,000-acre Eastern Maneuver Area (EMA); the 2,500-acre Surface Impact Area (SIA); the 900-acre Live Impact Area (LIA); and the 200-acre Eastern Conservation Area (**Figure 1-2**). Following cessation of military operations on the former VNTR, the Navy subdivided the former operational areas into 18 smaller parcels, or Munitions Response Sites, based on considerations such as historic use, geographic features, and land use. The sites were utilized for a wide range of military training exercises which included: air-to-ground bombing, Naval gunfire, Marine artillery firing, the open burning/open detonation of munitions and the firing of small arms. Access via roads to the former VNTR are controlled by locked access gates.

1.2.2 UXO 1

UXO 1 is 133 acres in size and was established as a conservation area in 1983. The site is managed as part of the Vieques National Wildlife Refuge with no planned public access or groundwater use. UXO 1 was not known to have been used as a target area for munitions; however, the site is located adjacent to the LIA (UXOs 2, 3, and 4), where naval gunfire and air-to-ground (ATG) training activities occurred from the 1970s to through 2003 and where open burning/open detonation (OB/OD) activities were conducted. The LIA generated an explosive safety arc that extended into the ECA. MEC and other munitions-related material have been identified within UXO 1 and were most likely from munitions directed toward the LIA that missed their intended target or debris from OB/OD operations.

A Comprehensive Conservation Plan (CCP)/Environmental Impact Statement (EIS) for the Vieques National Wildlife Refuge was completed by USFWS, which outlines the land use plan for managing the former VNTR as a wildlife refuge (DOI, 2007). Based on the CCP/EIS, roads within UXO 1 will be used to provide USFWS access to natural resource areas, such as the turtle nesting area along Playa Blanca, and for the USCG to access and maintain the navigation "light post" at the eastern end of UXO 1. However, the CCP/EIS shows no planned public access or groundwater use within UXO 1. Due to the presence of high cliffs and shallow coral reefs surrounding the ECA and the presence of the LIA to the west, the potential for trespassing at UXO 1 is low.

1.3 Summary of Investigations and Removal Actions

Previous environmental investigations/activities conducted at UXO 1, which included records reviews and interviews, site inspections and investigations, interim removal actions, and the RI, are summarized in **Table 1-1**. The types and distribution of surface MEC removed from UXO 1 during the TCRA are presented in **Table 1-2**. A conceptual site model was developed and updated throughout the investigation process to depict the site (**Figure 1-3**) and the results of the investigations and activities are summarized in the following subsections.

1.3.1 Physical Characteristics

UXO 1 ranges in elevation from approximately 0 to 60 feet above mean sea level (**Figure 1-4**). The northern, eastern, and southwestern portions are topographically high areas (considered upland areas) that gently slope toward an inland lagoon and the ocean. Large cliff faces separate the ocean from the land, except at Bahia Playa Blanca. The dominant vegetation type is low-growing, mostly native evergreen scrub along the eastern, southern, and northwestern portions of UXO 1. A forested scrub community with a greater abundance of invasive species and a narrow fringe of mangroves surrounds the 9-acre inland lagoon in the western portion of UXO 1. Vegetation

clearance was conducted throughout UXO 1 in association with the time-critical removal action (TCRA) and non-time critical removal action (NTCRA) (**Table 1-1**). A large portion of the evergreen scrub plant community that was cut back to near the ground surface during initial clearance activities is naturally recovering through vegetative re-growth. However, some of the more sensitive native plants have died as a direct result of being cut, while re-growth of other native species is being hindered by faster growth of adjacent non-native and invasive plants.

The lagoon is not tidally influenced and observations of the temporal presence of surface water suggest it is wholly or mostly the result of precipitation. No ephemeral streams occur within UXO 1.

The geology of UXO 1 is characterized as limestone and dolomite primarily exposed at the ground surface, and beach sand at Bahia Playa Blanca (United States Geological Survey, 1989). The upland areas generally contain bedrock exposed at the surface, loose stones, and very shallow soil between exposed bedrock. Within the lowland areas, beach sands intermixed with limestone are encountered at the surface. Sediment within the lagoon is primarily silt and clay with limited organic matter. Based on the bedrock observations, as well as observations made during soil sampling, groundwater within UXO 1 primarily occurs within the limestone and dolomite bedrock, is likely encountered near sea level, and is likely tidally influenced.

1.3.2 Nature and Extent of Contamination

MEC and Other Munitions-related Material

MEC and other munitions-related material were identified across UXO 1, likely a result of munitions directed toward the LIA (UXOs 2, 3, and 4) that missed their intended target. Surface removal of MEC, munitions debris (MD), range-related debris (RRD), and cultural debris was conducted across approximately 125 acres of UXO 1 during the TCRA; the remaining area of approximately 8 acres could not be accessed due to physical features (e.g., cliffs) (**Table 1-3, Figure 1-5**). In addition, approximately 10 acres of sandy beaches and roads within the TCRA area were also subject to subsurface removal of MEC, MD, RRD, and cultural debris during the NTCRA (**Figure 1-5**). Removal at the beaches was performed to a depth of 4 feet below ground surface (bgs) or until water was encountered. Removal at the roads was performed to a depth of 2 feet bgs or until bedrock was encountered.

Figure 1-6 shows the MEC, MD, and RRD removed during the TCRA. A total of 1,308 MEC were removed from the ground surface. Although the density of material varied throughout UXO 1, the overall density averaged 10 surface MEC per acre, transitioning from about 4.5 surface MEC per acre within the eastern portion of the site to about 16 surface MEC per acre within the western portion of the site near the LIA. In addition, 784 MD and 10,487 RRD were removed from the ground surface during the TCRA with a density and distribution similar to the MEC.

The types and distribution of subsurface MEC removed from UXO 1 during the NTCRA are presented in **Table 1-2** and shown in **Figure 1-7**. **Figure 1-7** also shows the MD and RRD removed during the NTCRA. The density and distribution of subsurface MEC are generally consistent with those observed for the surface MEC, with the density highest in the vicinity of the LIA. A total of 1,177 discrete anomalies and 6 anomaly polygons were investigated during the NTCRA; a total of 3,539 metallic items were found within those anomalies. A total of 97 MEC (approximately 3 percent of the total number of metallic items identified) were found from 91 of the anomalies (discrete and polygon) identified by digital geophysical mapping (DGM). Due to the presence of bedrock near the ground surface, a majority of the MEC (78 in total) were found within the first 18 inches of excavation. A total of 792 MD were recovered from 333 anomaly locations, and 2,650 RRD were recovered from 1,076 anomaly locations. The distribution and depth intervals were consistent with the MEC identified.

Over 1180 DGM anomalies were investigated as part of the NTCRA at UXO 1. Of these, a total of 156 anomalies were not recovered due to the following conditions: 1) at 23 anomaly locations, the anomaly was below the prescribed depth of excavation, 2) at 30 anomaly locations, groundwater was encountered before reaching the source of the anomaly and the excavation was terminated, and 3) at 103 locations where the initial DGM survey identified an anomaly, no anomaly was identified during the reacquisition process. The locations of the anomalies not recovered are presented on **Figure 1-8**.

There has been no discernable difference in the types of MEC recovered across the TCRA and NTCRA areas. Over 80 percent of the MEC recovered from UXO 1 were projectiles/mortars. The MEC most commonly found were 20

millimeter rounds, which accounted for over 60 percent (809 in total) of the MEC found on the surface and over 50 percent (51 in total) recovered from the subsurface.

Because subsurface MEC was recovered from the limited areas addressed during the NTCRA, it is assumed that subsurface MEC remains on the site. The overall density of subsurface MEC recovered at UXO 1 during the NTCRA was approximately 6 MEC per acre. Given that 16 of the 133 acres within UXO 1 were subsurface cleared of MEC, if the 6 MEC per acre average is consistent across the site, there are approximately 700 subsurface MEC items remaining at the site. These types of projections are subject to uncertainty. Based on the distribution of MEC recovered during the TCRA and NTCRA and the presence of bedrock near the ground surface, it is believed that the majority of the MEC are located within 18 inches bgs and that the density of MEC is highest in the western portion of UXO 1 and decreases toward the east.

Environmental Media

Soil, surface water, and sediment samples were collected during the RI to determine if the presence of MEC and MEC-related material had impacted the environmental media (CH2M HILL, 2012). No explosives were detected in subsurface soil, surface water, or sediment of the UXO 1 lagoon. Nitrobenzene was the only explosive detected in surface soil above a screening criterion; it was detected in one sample [98 NJ micrograms per kilogram ($\mu\text{g}/\text{kg}$)] above the soil screening level of 6.8 $\mu\text{g}/\text{kg}$. However, the detected concentration was between about two and three orders of magnitude below risk-based screening criteria, and the sample was collected along the boundary between UXO 1 and LIA. Inorganic constituents were detected in soil, surface water, and sediment; however, the concentrations were primarily attributed to background (CH2M HILL, 2012). The data collected from the soil across UXO 1 suggest leaching of contaminants to groundwater is not a concern.

1.3.3 Contaminant Fate and Transport

A detailed evaluation of contaminant fate and transport is presented in the RI Report (CH2M HILL, 2012). The potential for MEC at UXO 1 to release chemical contaminants to environmental media, from historical detonations and from deterioration of MEC and related munitions scrap, was initially identified as a potential contaminant fate and transport mechanism. However, the infrequent detections and low concentrations of explosives in surface soil and the absence of explosives in subsurface soil and the lagoon surface water and sediment indicate that the mechanism is insignificant (**Section 1.3.2**). The presence of inorganics was primarily attributed to background rather than the historical detonations and deterioration of MEC and related munitions scrap (CH2M HILL, 2012). Therefore, the potential migration of explosives and inorganics from surface or subsurface MEC from wind erosion, surface runoff, and leaching to and migration with groundwater is also insignificant. Further, surface MEC have been removed from all of the accessible areas of UXO 1, and subsurface MEC have been removed along beaches and roads (**Section 1.3.1**). Because there are still areas where subsurface MEC likely remains, there is the potential for subsurface MEC to become exposed at the ground surface through natural mechanisms, such as soil erosion over time.

1.3.4 Baseline Risk Assessment

Explosive Risk Evaluation

The MEC HA provides a “Hazard Level Category” score that ranges from 1 (most hazardous) to 4 (least hazardous). The UXO 1 MEC HA is presented in the RI Report (CH2M HILL, 2012), and resulted in the following:

- Hazard Level Category of 3 in areas that have been subject to surface removal only
- Hazard Level Category of 4 along roads that were subject to a removal depth of 2 feet
- Hazard Level Category of 4 along sandy beaches that were subject to removal to a depth of 4 feet

Human Health Risk Assessment

The HHRA considered USFWS workers engaged in a variety of wildlife refuge management and law enforcement activities, trespassers, and Coast Guard Workers because the land is designated as a wildlife refuge under the National Wildlife Refuge System Administration Act of 1966 in accordance with the Memorandum of Agreement (MOA) between the U.S. Department of Navy and U.S. Department of the Interior (Navy and DOI, 2003). Therefore, site use other than as a wildlife refuge is prohibited and other exposure scenarios (e.g., residential)

were not evaluated. Exposure pathways included (variously based on receptor) ingestion, dermal contact, and inhalation of chemicals of potential concern (COPCs) in soil; ingestion and dermal contact of COPCs in sediment; and dermal contact of COPCs in surface water. Groundwater is currently not used, nor will it likely be used in the future because the land is part of the Congressionally-mandated National Wildlife Refuge, and, therefore, was not evaluated. The non-cancer risk estimates (hazard indices) do not exceed 1.0 and no carcinogenic risks (excess cancer lifetime risks) are higher than 1×10^{-6} for any receptors evaluated for exposure to surface or subsurface soils, surface water, or sediment; therefore, no chemicals of concern (COCs) were identified and no unacceptable human health risks from chemical contaminants are present. However, because exposure scenarios evaluated were selected based on the current and future land use (i.e., wildlife refuge), it is unknown whether unacceptable risk would be present for the medium (i.e., groundwater) and/or exposure scenarios that were not evaluated (e.g., residential).

Ecological Risk Assessment

The ecological risk assessment evaluated both terrestrial and aquatic habitats. No COCs were identified for individual plant and animal receptor exposure to surface soil, surface water, or surface sediment exposures. Similarly, no COCs were identified for food web exposures. Thus, no unacceptable risks to ecological receptors are present at UXO 1.

TABLE 1-1

Summary of Previous Investigations and Environmental History*Feasibility Study Report**UXO 1, Eastern Conservation Area**Former Vieques Naval Training Range**Vieques, Puerto Rico*

Study/Activity	Author	Purpose of Study/Activity	Study/Field Work Date(s)	Report Date
Environmental Baseline Survey	Program Management Company	To disclose available, factual, relevant information regarding the environmental condition of the property. The information is used as a basis for determining the environmental suitability of the property for transfer.	March through May 2000	October 2000
Preliminary Range Assessment	CH2M HILL	To provide information about the types, quantities, constituents, and other factors related to the military munitions employed; and identify the type(s) and location(s) of any targets that may have been used at the MEC areas at the VNTR. The information is used to eliminate from further consideration suspect MEC areas that pose no threat to public health or environment and propose an initial explosives safety risk assessment to identify areas for further action.	November 2002	April 2003
Expanded Range Assessment/Site Inspection	CH2M HILL	To determine the presence and estimate the quantity of munitions at 17 unexploded ordnance (UXO) sites at the former VNTR.	January 2005 through December 2008	September 2010
Time-Critical Removal Action	CH2M HILL	To reduce the explosive safety risks to the public at the LIA and ECA by removing all MEC present or exposed on the ground surface in accessible areas.	June 2005 through February 2009	October 2010
Non-Time Critical Removal Action	CH2M HILL	To reduce the explosive safety risks to the public at the munitions response sites (including UXO 1), by removing subsurface MEC at beaches and along roads.	February through April 2011	NTCRA work is ongoing; Results included as part of the ECA RI
ECA (UXO 1) Background Investigation	CH2M HILL	This investigation was conducted as part of the overall ECA Remedial Investigation to determine background inorganic soil concentrations in lithologic areas similar to the ECA.	February 2011	Results included as part of the ECA RI
ECA (UXO 1) Remedial Investigation	CH2M HILL	To characterize the nature and extent of contamination and to assess potential risks to human health and the environment at the ECA.	December 2008 through February 2011	January 2012 (draft)

TABLE 1-2
MEC Recovered from UXO 1
Feasibility Study Report
UXO 1, Eastern Conservation Area
Former Vieques Naval Training Range
Vieques, Puerto Rico

Item Class	Item Type	Number of Surface MEC Removed During TCRA	Number of Subsurface MEC Removed During NTCRA
Bombs	MK-23 (Old-style)	---	2
	BDU-45	3	---
	MK-76/BDU 33 (25lb)	17	12
	MK-82 (500lb)	3	1
Flares-Pyrotechnics	MK-24 Flare (Parachute)	2	1
	MK-25 Flare (Marine Marker)	1	1
	MK-45 Flare (Aircraft)	13	---
	Other - WP igniter	1	---
MEC Component	Fuze, rocket motors, etc	45	2
Projectiles / Mortars	3"/50 (MK-27, MK-29, MK-33)	5	3
	5 in Projo	41	6
	8 in Projo	1	---
	20 mm Projo	809	49
	25 mm Projo	1	---
	30 mm Projo	218	2
	40 mm Projo	---	1
	75 mm Projo	1	1
	90 mm Projo	---	3
	105 mm Projo	1	2
155 mm Projo	10	---	
Rockets / Guided Missiles	2.75 in Rocket	130	11
Sub munitions	MK-118	6	0
Total		1,308	97

BDU bomb dummy unit
in inch/inches
MK mark
mm millimeters
Projo projectile
WP white phosphorous
--- no item found

Table 1-3

UXO 1 Acreages

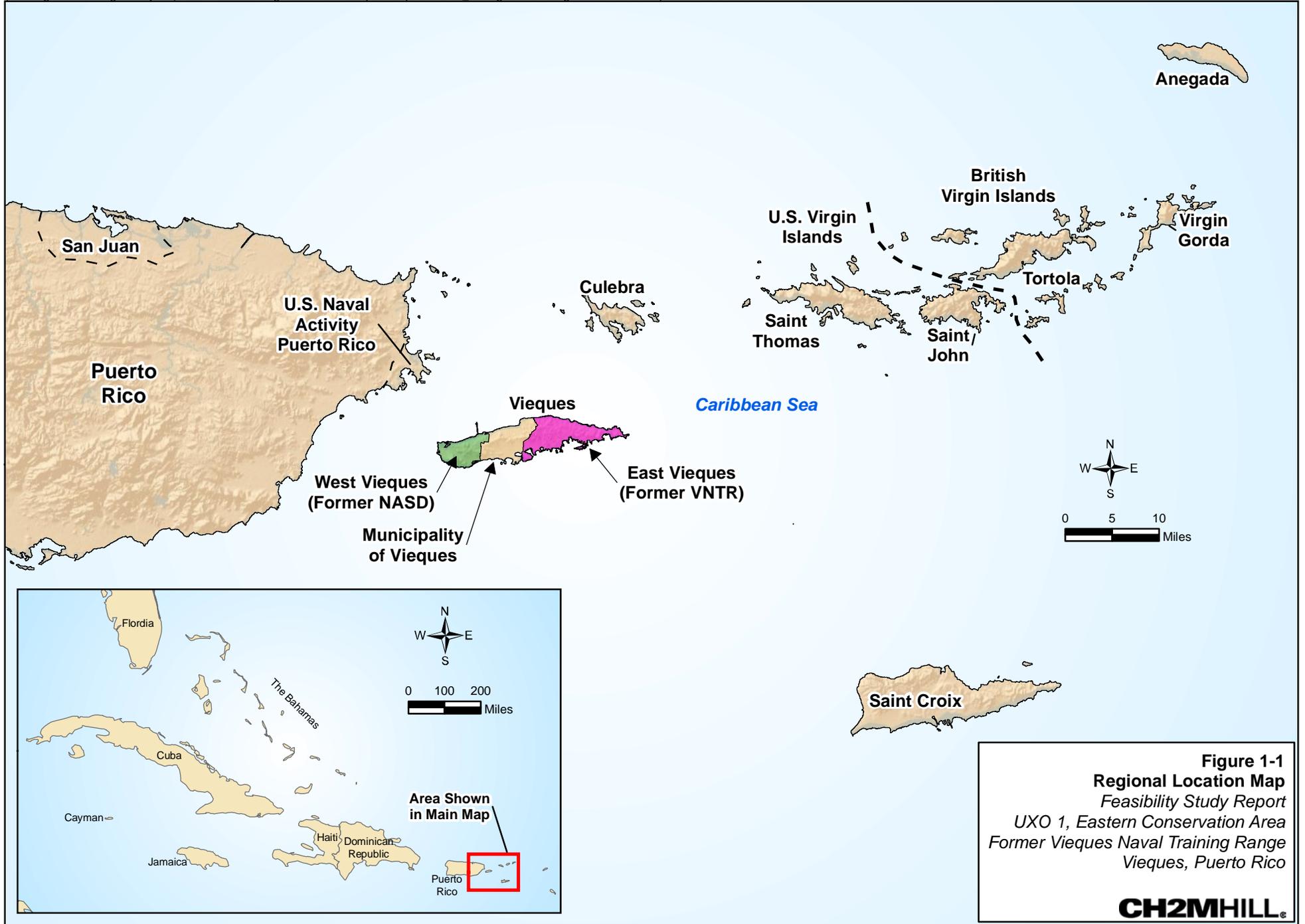
UXO 1, Eastern Conservation Area

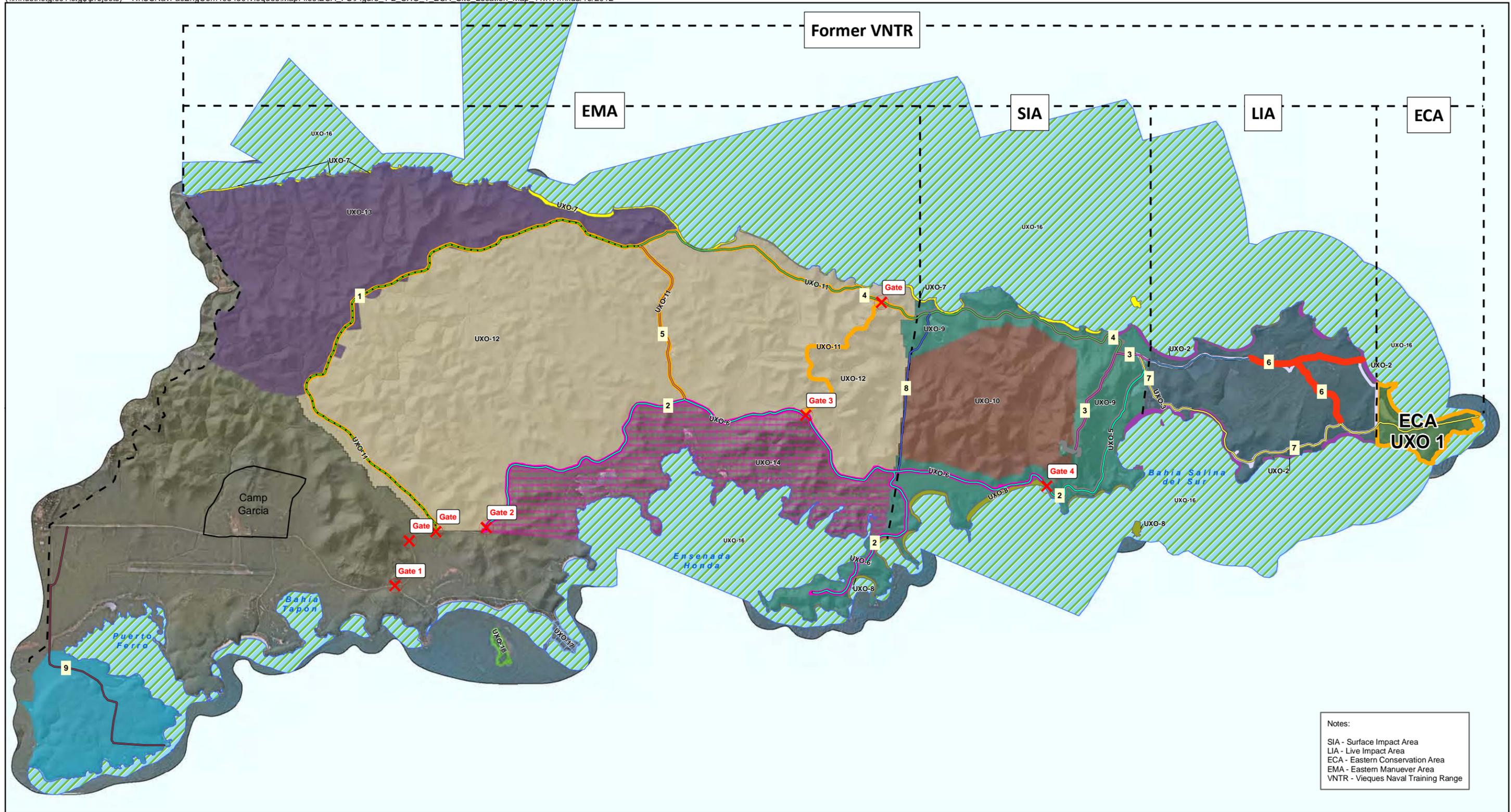
Feasibility Study Report

Former Vieques Naval Training Range

Vieques, Puerto Rico

	TCRA	NTCRA	Feasibility Study (Cost Estimate Support)		
	Surface Clearance Summary	Subsurface Clearance Summary	Breakdown of Areas Inaccessible/Cleared/Not Cleared of MEC	Estimated Vegetation Clearance Required for Additional MEC Clearance	Estimated Areas of Disturbance for Additional MEC Clearance
Total UXO 1 Size = 133 Acres	Inaccessible area (e.g., cliffs) cannot be cleared = 8 acres	Inaccessible area (e.g., cliffs) cannot be cleared = 8 acres	Inaccessible area (e.g., cliffs) cannot be cleared = 8 acres	Inaccessible area (e.g., cliffs) cannot be cleared = 8 acres	Inaccessible area (e.g., cliffs) cannot be cleared = 8 acres
	Total TCRA (surface clearance) area = 125 acres	Total NTCRA (subsurface clearance) area = 10 acres	Total NTCRA (subsurface clearance completed) area = 10 acres	Total NTCRA (subsurface clearance completed) area = 10 acres	Total NTCRA (subsurface clearance completed) area = 10 acres
		Remaining accessible area that has not been cleared of Subsurface MEC = 115 acres	Lagoon area not subsurface cleared of MEC = 9 acres	Lagoon area (no vegetation clearance required) = 9 acres	Area of subsurface disturbance that would be required for subsurface MEC removal = 68 acres
			Upland area not cleared of MEC = 106 acres	Area where bedrock not present at ground surface that would require vegetation clearance for subsurface MEC removal = 59 acres	
Approximate extent of near-surface bedrock, which would not require subsurface MEC removal or associated vegetation clearance = 47 acres	Approximate extent of near-surface bedrock, which would not require subsurface MEC removal or associated disturbance = 47 acres				





Notes:
 SIA - Surface Impact Area
 LIA - Live Impact Area
 ECA - Eastern Conservation Area
 EMA - Eastern Maneuver Area
 VNTN - Vieques Naval Training Range

- | | | | |
|---|--|--|---|
| <ul style="list-style-type: none"> Gates UXO Escort Required Camp Garcia UXO 1 Boundary | <p>Authorized Access for Qualified Personnel</p> <ul style="list-style-type: none"> 1 - EMA Range Access Road 2 - Range Access Road 3 - OP-1 Road 4 - North Shore Road 5 - EMA Connector Road 6 - North Road 7 - South Road 8 - SIA Boundary Road 9 - Puerto Ferro Road | <p>Munitions Response Sites</p> <ul style="list-style-type: none"> UXO 1 - ECA UXO 2 - LIA Beaches UXO 3 - LIA Roads UXO 4 - LIA Interior UXO 5 - SIA Restricted Roads UXO 6 - EMA/SIA Public Roads UXO 7 - EMA/SIA North Beaches UXO 8 - SIA South Beaches | <ul style="list-style-type: none"> UXO 9 - SIA Exterior UXO 10 - SIA Interior UXO 11 - EMA Public Roads UXO 12 - EMA Interior UXO 13 - EMA West UXO 14 - EMA South UXO 15 - Puerto Ferro UXO 16 - Underwater Areas UXO 17 - PAOC EE UXO 18 - Cayo de la Chiva |
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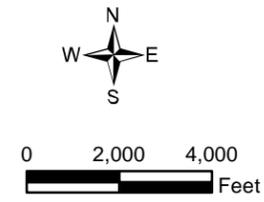
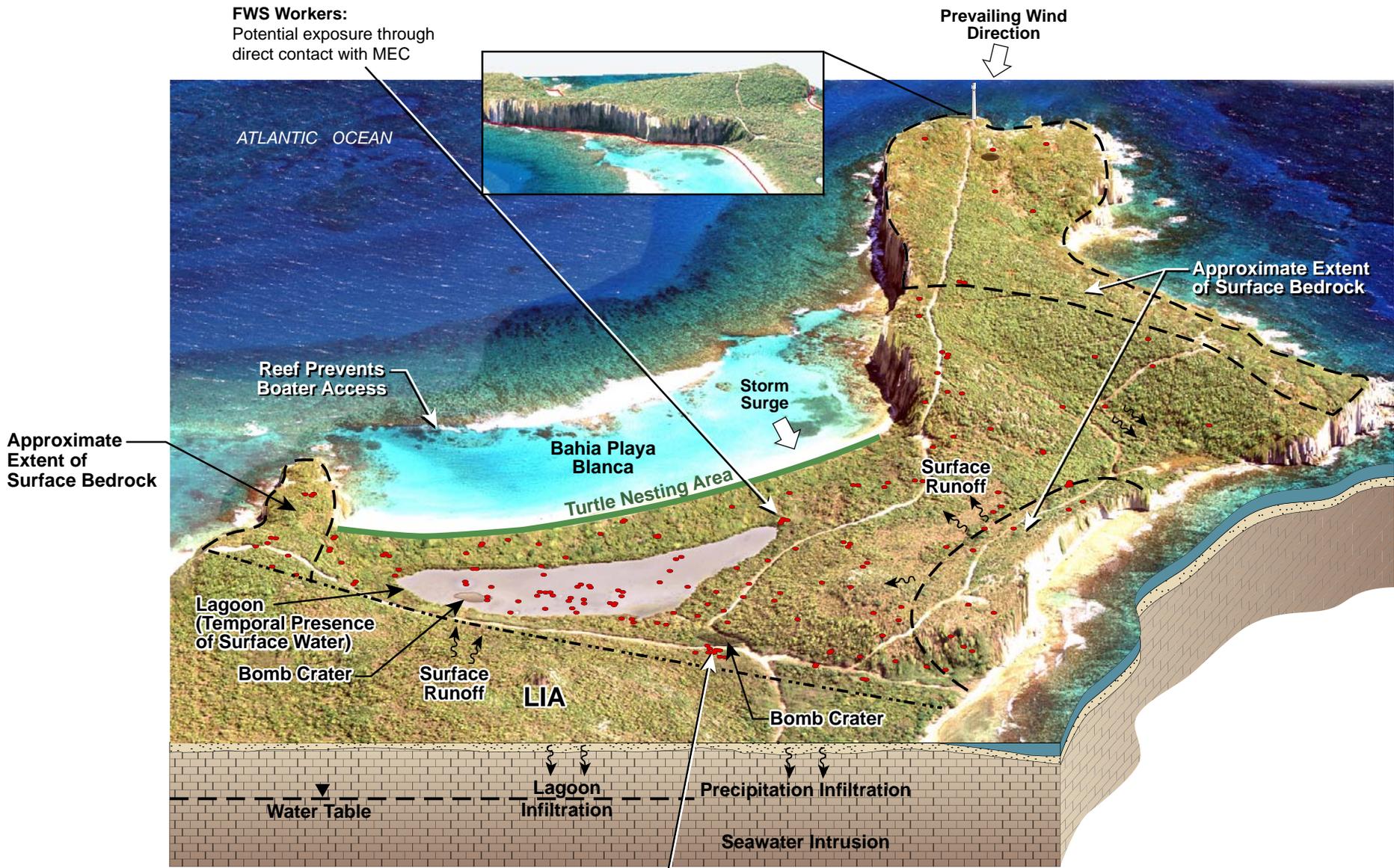


Figure 1-2
Site Location Map
 Feasibility Study Report
 UXO 1, Eastern Conservation Area
 Former Vieques Naval Training Range
 Vieques, Puerto Rico



- LEGEND**
- Ocean
 - Sand
 - Karstic Limestone and Dolomite
 - Munition Items



FIGURE 1-3
Conceptual Site Model
 Feasibility Study Report
 UXO 1, Eastern Conservation Area
 Former Vieques Naval Training Range
 Vieques, Puerto Rico



- Legend**
- Topographic Contour (10 foot interval)
 - UXO 1 Boundary

Notes:
 Topographic Contours derived from LIDAR.
 Topographic Contour elevations are feet above sea level at time of LIDAR survey.

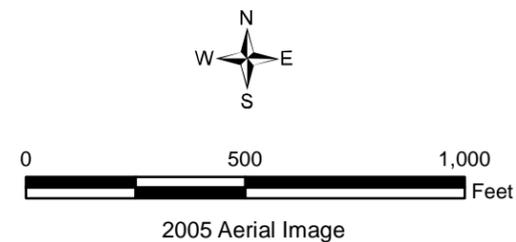
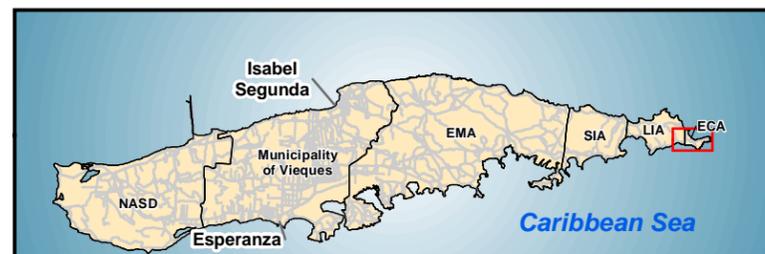
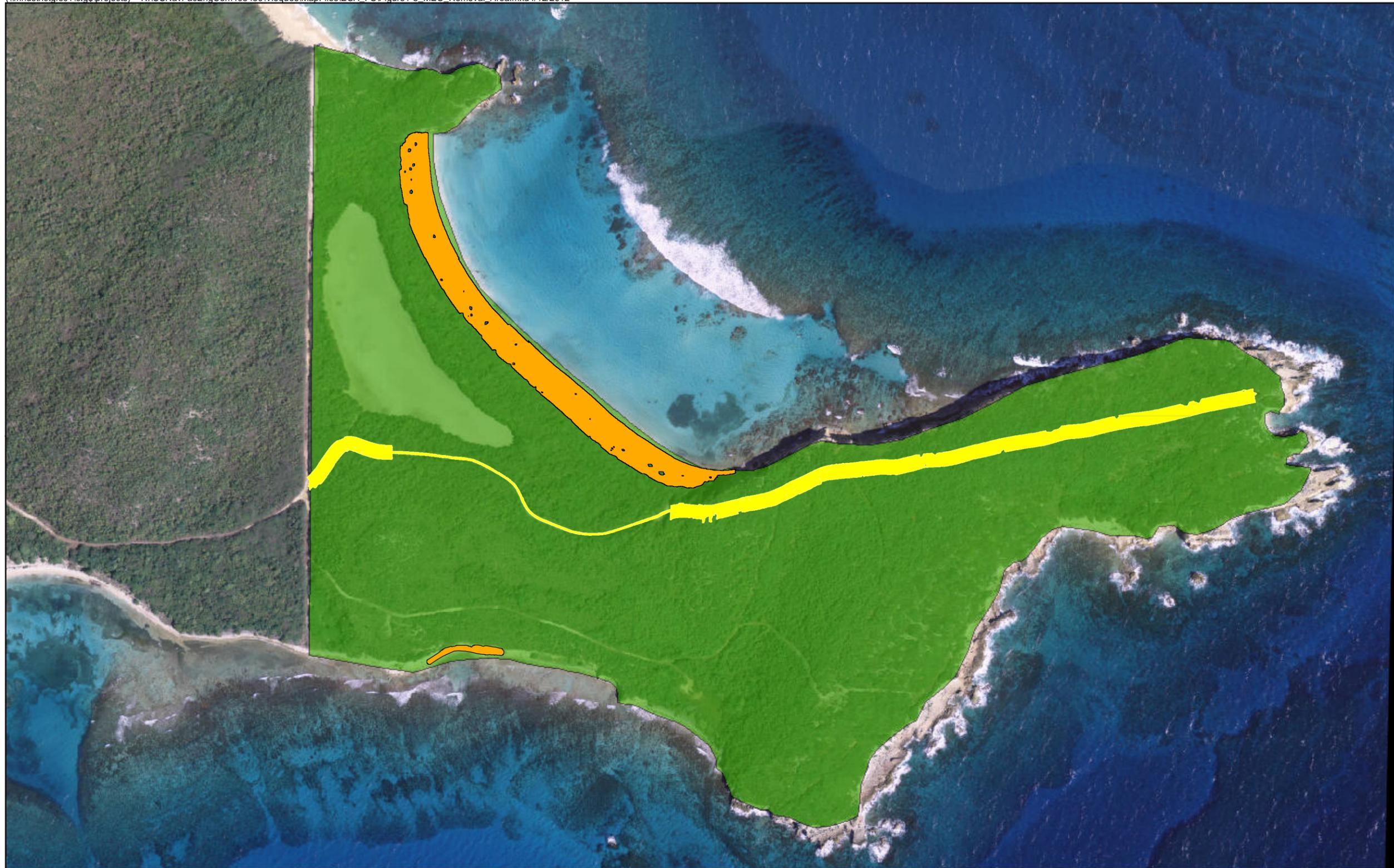


Figure 1-4
ECA Topographic Map
 Feasibility Study Report
 UXO 1, Eastern Conservation Area
 Former Vieques Naval Training Range
 Vieques, Puerto Rico



-  ECA NTCRA Subsurface MEC Removal Area (4-ft depth)
-  ECA NTCRA Subsurface MEC Removal Area (2-ft depth)
-  ECA TCRA Surface MEC Removal Area

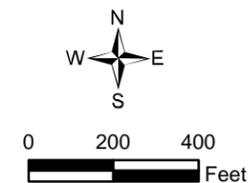


Figure 1-5
MEC Removal Areas
Feasibility Study Report
UXO 1, Eastern Conservation Area
Former Vieques Naval Training Range
Vieques, Puerto Rico



- Bombs
- Flares-Pyrotechnics
- MEC Component
- Projectiles / Mortars
- Rockets / Guided Missiles
- Submunitions
- MD (Scrap)
- RRD (Scrap)
- UXO 1 Boundary

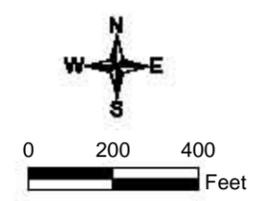


Figure 1-6
MEC, MD, and RRD Recovered During TCRA
Feasibility Study Report
UXO 1, Eastern Conservation Area
Former Vieques Naval Training Range
Vieques, Puerto Rico



- Bombs
- Flares-Pyrotechnics
- MEC Component
- Projectiles / Mortars
- Rockets / Guided Missiles
- MD (Scrap)
- RRD (Scrap)
- UXO 1 Boundary

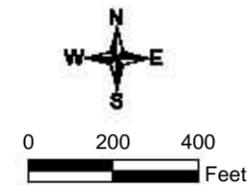
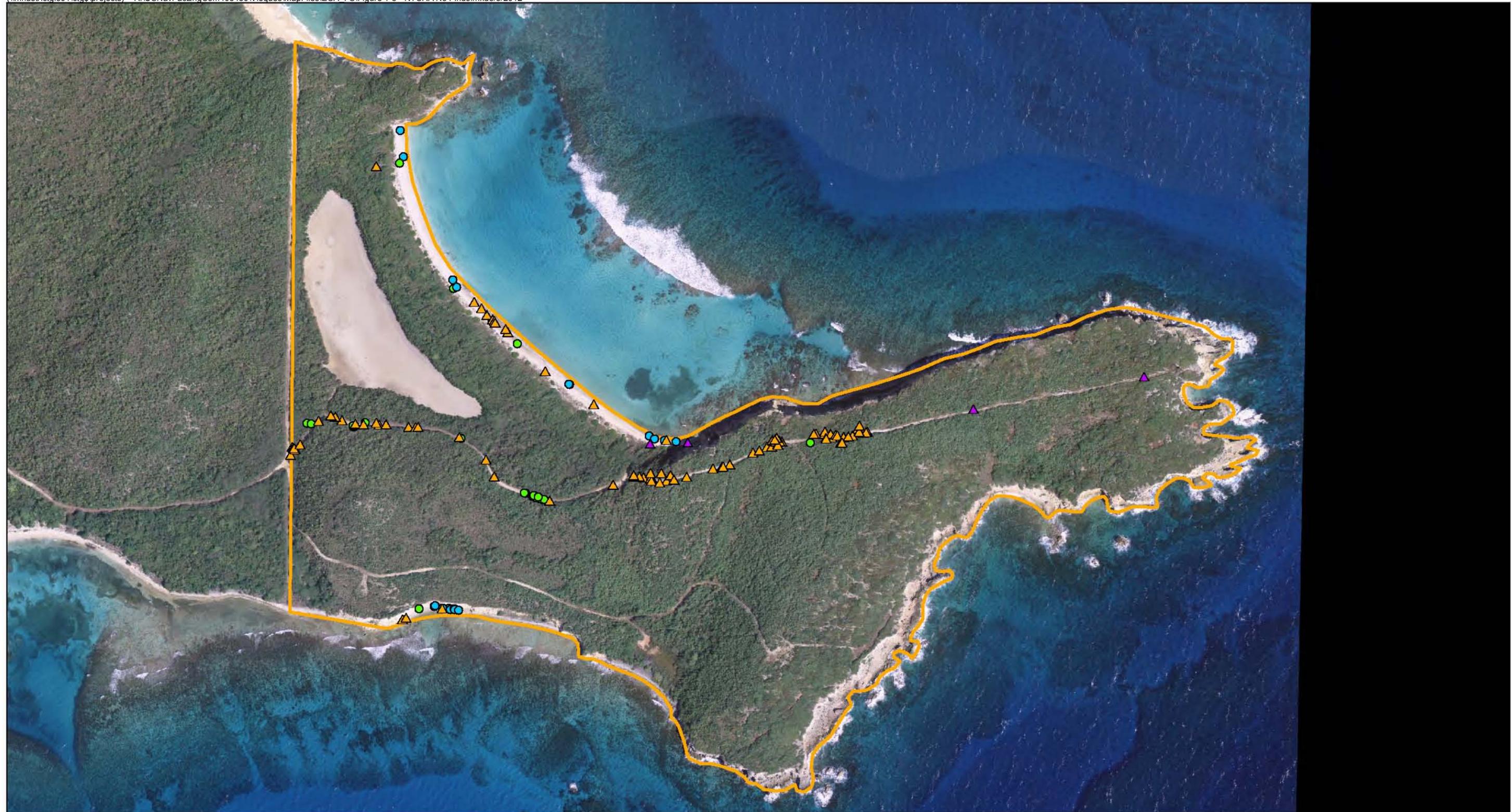


Figure 1-7
MEC, MD, and RRD Recovered During NTCRA
Feasibility Study Report
UXO 1, Eastern Conservation Area
Former Vieques Naval Training Range
Vieques, Puerto Rico



-  No Find – reacquisition mV below 2.5 mV threshold
-  No Find - Below Depth
-  No Find - Below Water
-  No Find – no metallic item(s) recovered from anomaly location
-  UXO 1 Boundary

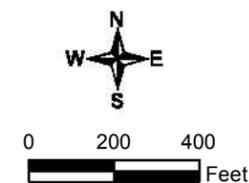


Figure 1-8
No Find Locations During NTCRA
Feasibility Study Report
UXO 1, Eastern Conservation Area
Former Vieques Naval Training Range
Vieques, Puerto Rico

Identification and Screening of Technologies

This section presents the RAOs, ARARs, and the initial steps to develop remedial alternatives, including the identification of general response actions (GRAs) and screening of potential remedial technologies for UXO 1.

2.1 Remedial Action Objectives

RAOs consist of specific goals for protecting human health and the environment. The following RAOs were developed to be protective of current and potential future receptors, in accordance with the current and intended future land use (i.e., wildlife refuge), when evaluating potential remedial alternatives:

- Minimize the explosive safety risk associated with MEC by minimizing the potential for uncontrolled human contact with MEC potentially present in site soil and lagoon.
- Maintain land use that is consistent with the Memorandum of Agreement between the U.S. Department of the Navy and U.S. Department of Interior Concerning the Transfer of Department of Defense Properties on the Eastern End of Vieques Island (Navy and DOI, 2003).

2.2 Applicable or Relevant and Appropriate Requirements

CERCLA remedial actions must meet ARARs for selected remedies unless a specific ARAR waiver is requested. ARARs are federal and state (commonwealth) public health and environmental requirements used to help define the extent of site cleanup, identify sensitive land areas or land uses, develop remedial alternatives, and direct site remediation.

Applicable requirements are cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state (commonwealth) law that address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstances at the site.

Relevant and Appropriate requirements are cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state (commonwealth) law that are well suited to the particular site. While not necessarily “applicable” to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstances of the site, relevant and appropriate requirements address problems or situations sufficiently similar to those encountered at the site to justify their use.

Factors TBC are non-promulgated advisories or guidance, issued by federal or state (commonwealth) government, that are not legally binding and do not have the status of potential ARARs. However, in many circumstances such factors are considered along with ARARs in determining the level of cleanup required to protect human health and the environment.

Remedial actions must comply with both federal and state (commonwealth) ARARs. For a state (commonwealth) requirement to be an ARAR, it must meet three criteria:

- It must meet the definition of an ARAR.
- It must be more stringent than federal requirements.
- It must be a promulgated standard, requirement, criterion, or limitation under a state (commonwealth) environmental or facility citing law.

Onsite CERCLA response actions must meet substantive requirements but not administrative requirements. Substantive requirements deal directly with actions or with conditions in the environment. Administrative requirements implement the substantive requirements by prescribing procedures such as fees, permitting, and inspection that make substantive requirements effective. This distinction applies to onsite actions only; offsite response actions are subject to all applicable standards and regulations, including administrative requirements such as permits.

There are three types of ARARs. *Location-specific* ARARs restrict responsive activities and the occurrence of chemicals in certain sensitive environments, such as wetlands (for example, the Endangered Species Act). *Action-specific* ARARs are activity or technology based, which typically control remedial activities that generate hazardous wastes (for example, RCRA). *Chemical-specific* ARARs are health- or risk management-based numbers or methodologies that provide concentration limits for the occurrence of a chemical in the environment (for example, USEPA maximum contaminant levels). Remedial actions must comply with both federal and state (commonwealth) ARARs. The statutes and regulations listed in **Appendix A** contain requirements deemed to be potential ARARs at UXO 1. Location-specific ARARs relate to the coastal environment and wildlife habitat of VNTR. Action-specific ARARs are primarily associated with the management of MEC and lagoon water management. There are no chemical-specific ARARs for UXO 1 because there are no COCs.

2.3 General Response Actions

The GRAs describe the broad range of actions that will satisfy the RAOs at the site. GRAs may include no action, institutional controls, containment, removal, treatment, or a combination of these. Consideration of the No Action GRA is required by CERCLA. The GRAs for UXO 1, no action; institutional controls; containment; removal; and treatment, are presented in **Table 2-1**.

With the exception of the No Action alternative, each GRA would be implemented through site-specific remedial technologies. In this context, the following definitions apply:

- Remedial technologies are defined as the general categories of remedies under a GRA.
- Process options are specific categories of remedies within each remedial technology. The process options are used to implement each remedial technology.

2.4 Screening of Remedial Technologies and Process Options

The technology types and process options available for site media and remediation of MEC in soil were screened to identify those that may be applicable at UXO 1. **Table 2-1** summarizes the results of the technology screening process and process options retained for further evaluation. Certain technologies and/or process options are not appropriate for implementation at UXO 1, because of impracticality, limited effectiveness, site conditions, economics, or access, and were excluded from further consideration.

2.5 Sustainability

Executive Order 13242, *Strengthening Federal Environmental, Energy, and Transportation Management*, requires Federal agencies to implement sustainable practices. Sustainability is a *greening* process focused on energy conservation, reduction of greenhouse gases, waste minimization, and re-use and recycling of materials. These considerations are not NCP requirements for remedial alternatives, but are considered during the alternative selection process.

Green remediation results in effective cleanups minimizing the environmental and energy footprints of site remediation and revitalization (USEPA, 2008). Sustainable practices emphasize the need to more closely evaluate core elements of a cleanup project, compare the site-specific value of conservation benefits gained by different strategies of green remediation, and weigh the environmental trade-offs of potential strategies.

The sustainability of each alternative is evaluated by the SiteWise™ tool. SiteWise™ is a stand-alone analytical tool to efficiently and systematically conduct a sustainability analysis of remediation technologies, thereby providing a tool for selecting a remediation alternative that is based not only on the nine NCP selection criteria as detailed in Section 4, but also on the basis of the environmental footprint of the alternative. This analysis evaluates the environmental footprint of each remedial alternative considered in terms of five metrics, comprising:

1. Greenhouse gases (GHGs) reported as carbon dioxide equivalents (CO₂e), consisting of carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O)

2. Energy usage [expressed as British Thermal Unit (BTU)]
3. Water consumption (gallons)
4. Air emissions of criteria pollutants consisting of oxides of nitrogen (NO_x) and sulfur (SO_x), and particulate matter (PM)
5. Accident risk (risk of injury and risk of fatality)

A low environmental footprint indicates low deleterious impacts to environmental and social metrics, which collectively make up the SiteWise™ sustainability metrics. Conversely, a high environmental footprint indicates high deleterious impacts associated with the SiteWise™ metrics. A summary of the sustainability analysis for UXO 1 is included in **Appendix B**. The major conclusions of this sustainability analysis are incorporated into the short-term effectiveness criteria evaluation of this report.

TABLE 2-1

Technology Screening Summary

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General Response Actions	Remedial Technology	Process Options	Descriptions	Effectiveness	Implementability	Relative Cost	Retain	Reject
No Action	None	None	No active remedial action. This process option is retained to provide the basis for comparing active process options and technologies.	Not effective in protecting human health. Although previous removal actions limited the potential for direct contact for MEC by removing MEC from areas with greatest potential for exposure, alternative does not include measures to minimize uncontrolled human exposure to remaining MEC or with potentially contaminated media that may pose unacceptable risk.	Difficult to implement due to challenge of obtaining regulatory acceptance.	Low	x	
Institutional Controls	Administrative Restrictions	Land-Use-Controls (LUCs) (Engineering and institutional controls)	LUCs issued for areas with potential presence of MEC and potentially contaminated media that poses potential unacceptable risk to control property use. The site is already designated a National Wildlife Refuge. The Navy uses a Web-based management tool, LUC Tracker, as part of the Naval Installation Restoration Information System.	Effective in protecting in human health by minimizing the potential for direct human contact with MEC and potentially contaminated media that potentially poses potential unacceptable risk through control of land use.	Easy to implement	Low	x	
	Access Restrictions	Fences and Signs	Security fences/signs installed and maintained in areas with restricted use (i.e., potential presence of MEC).	Effective in protecting human health by limiting the potential for direct human contact with MEC and potentially contaminated media that may pose unacceptable risk through control of site access	Easy to implement. Site currently partially restricted by locked, gated road with signage and topography/landscape features (e.g., steep cliffs, shallow coral barrier) that discourage trespassing.		x	
Containment	Engineered Cap	Asphalt, concrete, geomembrane, or clay cap	Minimize MEC safety hazard on land and/or lagoon and exposure to potentially contaminated media that may pose unacceptable risk.	Effective in limiting potential for erosion to expose subsurface MEC; however, minimal added effectiveness because surface clearance was already conducted during an interim action. MEC will remain onsite beneath cap. Effective in controlling contact with potentially contaminated media that poses potential unacceptable risk.	Difficult to implement. Requires extensive vegetation clearing, coordination of lagoon activities with dry period(s), and MEC clearance. Easier to implement in limited areas where hard surfaces are desired, such as roadways; however, no new roadways are planned and existing roadways were cleared of MEC during an interim action.	High		x
Removal	MEC Removal	MEC Removal	Removal of MEC from the subsurface	Effective in eliminating future potential for exposure to MEC	Moderate to difficult relative to items encountered and site conditions (e.g. vegetation, lagoon, etc.)	High	x (MEC only)	
Treatment	Physical Treatment	MEC Detonation	Destruction of MEC through detonation.	Effective in eliminating the explosive hazard associated with MEC.	Moderate to implement. Standard detonation procedures are established for the site; however, administrative details require coordination.	Moderate	x (MEC only)	

Notes:

Effectiveness is the ability to perform as part of an overall alternative that can meet the objective under conditions and limitations that exist onsite

Implementability is the likelihood that the process could be implemented as part of the remedial action plan under the physical, regulatory, technical, and schedule constraints.

Relative cost is for comparative purposes only and it is judged relative to the other processes and technologies that perform similar functions.

Development and Description of Remedial Alternatives

This section presents a description of remedial alternatives developed to meet the RAOs. Remedial alternatives were developed by assembling remedial technologies and representative process options after the initial screening process. Remedial alternatives were developed based on site-specific considerations primarily related to the nature of the MEC and site physical characteristics. Cost estimates for each remedial alternative are provided in **Appendix C**.

The following three remedial alternatives are developed to address MEC safety risk in soil, including:

- Alternative 1— No Action
- Alternative 2— Land Use Controls (LUCs) and Limited MEC Removal
- Alternative 3— Subsurface MEC Removal and LUCs

A detailed description of each of these alternatives is provided below.

3.1 Alternative 1 – No Action

Alternative 1 is required by the NCP to be retained throughout the FS process as a baseline for comparison to the other approaches. No Action means that no remedial actions or process options are implemented, and no attempt is made to meet the RAOs.

The components and assumptions of Alternative 1 include the following:

- The site would remain in its current condition (MEC surface removal previously completed for the 125-acre area and MEC subsurface removal completed along approximately 6 acres of beaches and 4 acres of access roads) (**Figure 1-5**); no additional surface or subsurface MEC removal would be conducted for the remaining areas.
- Access to the site is currently restricted by locked gates and signage along roads leading to UXO 1 (**Figure 1-2**); however, no capital or operation and maintenance (O&M) activities would be involved, and partial restrictions in place would not be maintained, enforced, or monitored.
- 5-year reviews would be performed (assumed to be for 30 years for the purposes of FS cost estimating) with periodic evaluation of the effectiveness of this alternative.

Alternative 1 does not meet the RAOs. Although the explosives safety risk with MEC by authorized site workers and trespassers was significantly reduced by the previous removal actions, the alternative does not include any means of controlling exposure to the hazards that remain on site. MEC may become exposed over time due to natural processes (e.g., erosion) or by trespasser activities (e.g., digging or clearing). Additionally, the alternative does not minimize uncontrolled human contact with potentially contaminated media that may pose unacceptable risk.

3.2 Alternative 2 – Limited MEC Removal and LUCs

Alternative 2 focuses primarily on using LUCs, including engineering controls (i.e., physical barriers) and Institutional Controls (ICs), to manage the MEC safety risks and includes monitoring to evaluate their effectiveness and identify changes in site conditions that may increase MEC safety risks. Alternative 2 also includes limited MEC removal (e.g., removal of any MEC identified during monitoring, subsurface removal of MEC along additional trails to allow USFWS to gain access to turtle nesting habitats), for which areas will be identified on an as-needed basis. It also includes LUCs to minimize uncontrolled human contact with potentially contaminated media that may pose unacceptable risk. The implementation of the LUCs would be in accordance with USEPA and United States Department of Energy (DOE) published guidance on implementing ICs for CERCLA and Resource Conservation and Recovery Act (RCRA)

response actions (USEPA, 2000a). Alternative 2 also includes vegetative restoration of disturbed areas for the limited MEC removal activities and installation of engineering controls. The conceptual layout of Alternative 2 is shown in **Figure 3-1**.

The specific objectives of the LUCs are to minimize the potential for trespassing and intrusive activities that would cause uncontrolled exposures to MEC and to minimize uncontrolled human contact with potentially contaminated media that may pose unacceptable risk.

The major components and assumptions for Alternative 2 include the following:

- Limited MEC removal would be conducted (e.g., subsurface clearance of additional access pathways for USFWS to conduct monitoring of sea turtle habitats or surface removal of MEC exposed by erosion, subsurface clearance for tree planting and land management).
- Physical barriers (e.g., boundary demarcation, fencing, gates, signage) and ICs (e.g., deed notations) would be implemented to deter future access, provide a mechanism for informing potential trespassers of the access restrictions, and minimize uncontrolled human contact with potentially contaminated media that may pose unacceptable risk. The LUC boundary encompassing UXO 1 would be surveyed by a professional land surveyor and marked in the field. It is possible that as part of planned land use, construction/land management activities would be performed (e.g., construction/maintenance of access roads, tree planting, turtle egg recovery). Therefore, the LUCs will provide the ability for planned land use development and management with UXO support [e.g., anomaly avoidance under the direction of a qualified unexploded ordnance (UXO) technician] and to optimize any long-term monitoring (LTM) program. The LUCs will also minimize uncontrolled human contact with potentially contaminated media that may pose unacceptable risk.
- For the purposes of the FS, it is assumed that 2,610 linear feet of fence and 53 signs (i.e., 50-ft spacing) would be installed approximately along the western edge of the LIA to restrict access to both the LIA and UXO 1 (to which land access requires passage through LIA). The exact location of the fence will be detailed in the remedial action work plan based on topography, vegetation, and the site management plan for LIA. Prior to the fence installation, a fence buffer zone along the proposed fence line would be cleared of vegetation and the fence would be installed while practicing anomaly avoidance techniques. For cost estimating purposes, a 3-wire fence is assumed. However, the actual style of fence installed will be included in the remedial action work plan and will be based on such factors as site conditions, accessibility by vehicles, types of vegetation, land owner preference, etc.
- A LTM program would be established, including periodic site inspections to: identify any MEC that has been exposed at the surface from erosion, observe any indications of trespassing, and repair any damage to fencing/signage. For the purposes of the FS, it is assumed that site inspections will be conducted twice annually, once scheduled and once after a major storm event, for a period of 30 years. The actual frequency and duration of LTM will be included in the LTM work plan provided for regulatory review and approval and will be based on such factors as remaining potential presence of MEC, site conditions, climatic conditions, etc.
- Five-year reviews (for an assumed 30 years) would be performed for periodic evaluation of the effectiveness of the LUCs.
- Vegetation restoration would be conducted in cooperation with USFWS.

3.3 Alternative 3 – Subsurface MEC Removal and LUCs

Alternative 3 consists of subsurface MEC removal throughout UXO 1, limited surface clearance of MEC (as defined in Alternative 2), and the implementation of LUCs, and includes LTM to monitor their effectiveness and identify changes in site conditions that may increase the potential MEC safety risks. Alternative 3 also includes LUCs to minimize uncontrolled human contact with potentially contaminated media that may pose unacceptable risk. The subsurface MEC removal component includes MEC removal to a depth of 2 feet bgs over the entire area of UXO 1, including the lagoon, with the exception of the inaccessible portions of the site (i.e., cliffs) and subsurface areas cleared during the NTCRA. The depth of 2 feet has been selected for this alternative with consideration of the

likely depth of disturbance for the future construction/land management activities (e.g., construction/maintenance of access roads, tree planting), to provide a buffer to minimize the exposure of MEC from soil erosion, and to minimize the explosive safety risk based on the expectation that they are present within 2-foot bgs (**Section 1.3.2**). Based on the distribution of MEC recovered during the TCRA and NTCRA and the presence of bedrock near the ground surface, it is believed that the majority of the MEC are located within 18 inches bgs. The LUCs for this alternative are the same as described in Alternative 2 (**Figure 3-1**) because, although subsurface MEC removal will reduce the potential for exposure to MEC, industry standards do not currently accept that 100% MEC removal is possible and thereby require LUCs. The conceptual layout of the other elements of Alternative 3 is shown in **Figure 3-2**.

The MEC removal would follow a similar approach used during the NTCRA action (CH2M HILL, 2008), including mobilization and demobilization, digital geophysical mapping, habitat survey, vegetation clearance, anomaly detection, MEC removal, demilitarization of recovered MEC items, site restoration, and re-vegetation. The only site restoration activities are assumed to be backfilling of excavation holes with excavated soils following the removal activities.

The major components and assumptions for Alternative 3 include:

- Vegetation clearance with anomaly avoidance support would be required for the entire accessible and vegetated portion of the terrestrial area [estimated as 59 acres, based on 125 acres where surface clearance was able to be performed minus the 10-acre area previously cleared during the NTCRA, the estimated 47 acres with exposed bedrock (**Figure 1-5**), and the 9-acre lagoon].
- Limited surface clearance of MEC would be conducted (e.g., to remove MEC exposed by erosion).
- Subsurface MEC removal to a depth of 2 ft bgs (or groundwater or bedrock if shallower than 2 feet bgs) would be performed within the entire accessible terrestrial area of UXO 1 that was not addressed during the NTCRA. For cost estimating purposes, it is assumed that 47 acres of the site have exposed surface bedrock and will not require any subsurface MEC removal.
- The lagoon would need to be dewatered. Although the lagoon is dry at times, restricting work to only dry periods would likely have significant schedule impacts.
- Subsurface MEC removal to a depth of 2 feet bgs (or groundwater or bedrock if shallower than 2 feet bgs) would be performed within the 9-acre lagoon area.
- Vegetation restoration would be conducted in cooperation with USFWS.
- Physical barriers and ICs will be implemented as described in Alternative 2.
- A LTM program would be established as described in Alternative 2.
- Five-year reviews (for an assumed 30 years) would be required as described in Alternative 2.



- Legend**
- ▲ Warning Sign
 - ⊗ Gate
 - Proposed Fence Line
 - ECA Land Use Control Boundary

Note:
 The area of limited MEC removal is not depicted on this figure because the actual limited MEC removal area will be based on future needs by FWS. Activities that may require limited MEC remove include tree planting and clearance of new pathways to access areas for land management activities such as turtle nest monitoring. Therefore, limited MEC removal will be conducted on an as-needed basis.

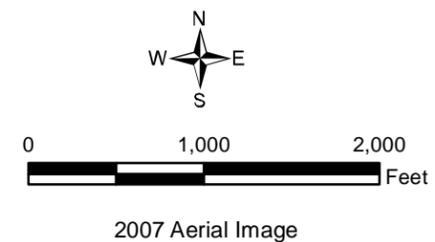
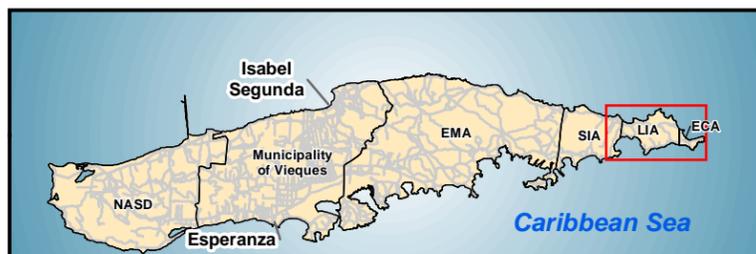
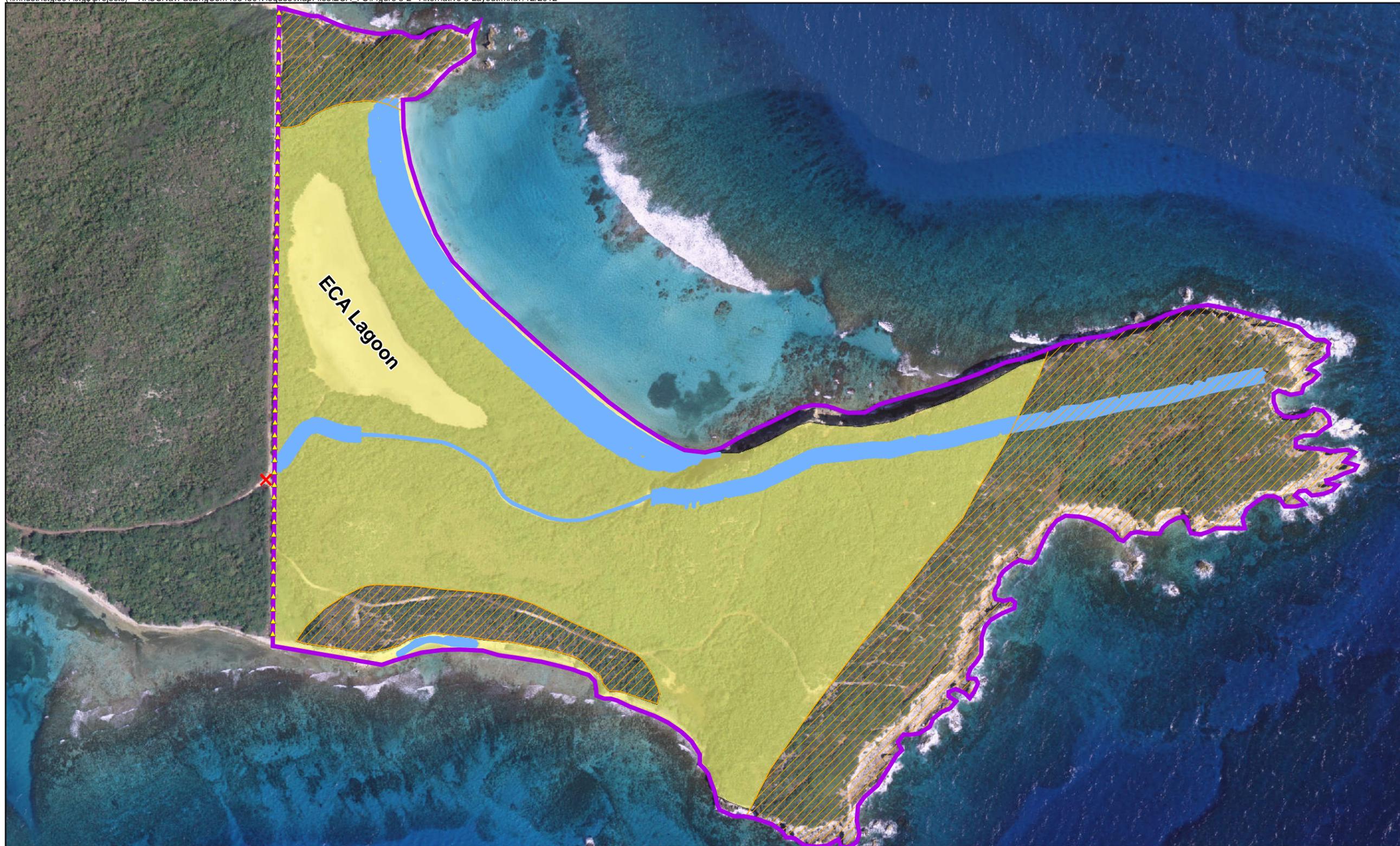


Figure 3-1
Alternative 2 Layout
 Feasibility Study Report
 UXO 1, Eastern Conservation Area
 Former Vieques Naval Training Range
 Vieques, Puerto Rico



Legend

-  Gate
-  Warning Sign
-  ECA Land Use Control Boundary
-  No Additional MEC Clearance - Subsurface MEC Removal Previously Conducted
-  Subsurface MEC Removal Area (Depth of 2ft bgs, or groundwater or bedrock if shallower)
-  Approximate Extent of Exposed Bedrock

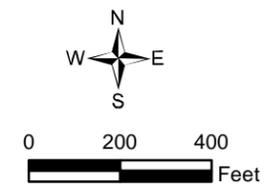


Figure 3-2
Alternative 3 Layout
 Feasibility Study Report
 UXO 1, Eastern Conservation Area
 Former Vieques Naval Training Range
 Vieques, Puerto Rico

Detailed Analysis of Remedial Alternatives

This section presents a detailed analysis of the remedial alternatives developed in Section 3. The detailed analysis of remedial alternatives follows the methodology outlined in the NCP. Alternatives are then compared against one another to highlight differences and preferential characteristics corresponding to MEC.

4.1 Evaluation Criteria

CERCLA guidance requires evaluation of each alternative against nine criteria listed in 40 Code of Federal Regulations (CFR) 300.430(e)(9). Criteria were published in the March 8, 1990, *Federal Register* (55 FR 8666), as a basis for comparing relative performance, implementability, and cost of alternatives. This approach is intended to provide sufficient information for comparison of alternatives, and for selection of the most appropriate site-specific remedial action. Evaluation criteria are listed below:

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

The first two categories from the above list are mandatory criteria for an alternative's consideration, and are referred to as *threshold criteria*. However, alternatives which do not satisfy ARAR requirements *can* be considered if a specific ARAR waiver is granted. The next five categories are the primary criteria upon which the detailed analysis is based, and are referred to as "balancing criteria." The remaining two evaluation categories are considered *modifying criteria* that are to be evaluated following the public comment process. The identified remedial alternatives will be evaluated in this FS for the first seven criteria, which are defined below.

4.1.1 Threshold Criteria

Threshold criteria are standards that an alternative must meet to be eligible for selection as a remedial action. There is little flexibility with meeting the threshold criteria—the alternative must meet them or it is unacceptable, unless a waiver is obtained from an ARAR where one or more site exceptions defined in the NCP occur.

- **Overall Protection of Human Health and the Environment.** Protectiveness is the main requirement that remedial actions must meet under CERCLA. It is an assessment of whether each alternative achieves and maintains adequate protection of human health and the environment. A remedy is protective if it eliminates, reduces, or controls potentially unacceptable risks posed by the site through each exposure pathway. The RAOs are established based on protectiveness.
- **Compliance with ARARs.** Compliance with ARARs is one of the statutory requirements of remedy selection. This criterion is used to determine whether the alternatives would meet the pertinent applicable federal, state (commonwealth), and local ARARs identified above.

4.1.2 Balancing Criteria

Unlike threshold criteria, the five balancing criteria detailed below weigh trade-offs between alternatives. A low rating on one balancing criterion may be compensated by a high rating on another. Balancing criteria represent principles upon which the detailed evaluation and comparative analysis of alternatives is based.

- **Long-term Effectiveness and Permanence.** CERCLA emphasizes selection of remedies which ensure both short- and long-term protection of human health and the environment. This criterion evaluates residual risks that may persist after implementation of a remedial action (or selection of a "no further action" alternative). Assessment includes evaluation of the adequacy and reliability of controls. Factors considered appropriate include the following:
 - Magnitude of residual risks as a result of untreated waste, byproducts, or following conclusion of remedial activities. Degree of residual hazards, primarily the volume with respect to MEC, should be considered.
 - Adequacy and reliability of controls necessary to manage untreated waste. Evaluation should consider long-term protection from residuals, potential technical modifications that may be required, and potential hazards posed by alternative replacement.
- **Reduction of Toxicity, Mobility, and Volume through Treatment.** This criterion addresses the statutory preference for remedies that employ treatment to significantly reduce the toxicity, mobility, or volume of the hazardous substances. That preference is satisfied when treatment is used to reduce the principal threats at a site by reducing the total volume of affected media. This criterion is specific to evaluating only how the treatment reduces toxicity, mobility, and volume. It does not address containment actions such as capping or covering.
- **Short-term Effectiveness.** This criterion addresses short-term impacts of the remedial alternatives by examining the effectiveness of alternatives in protecting human health and the environment during construction and implementation activities. Short-term impacts include runoff, dust, vapor, access issues, traffic, potential spills, noise and other byproducts of construction and remedy implementation, until response objectives are achieved. Short-term effects are evaluated against the following considerations:
 - Short-term risks that might be posed to the community during implementation of an alternative.
 - Potential impacts to workers during remedy implementation, including effectiveness and reliability of protective measures, with consideration of the accident risk calculated by SiteWise™.
 - Potential environmental effects (i.e., SiteWise™ environmental footprint calculation) from remedy implementation, including effectiveness and reliability of mitigation measures.
 - Timeframe for implementation and achieved protection.
- **Implementability.** This criterion evaluates technical and administrative feasibility of an alternative, to include availability of materials and services required for implementation. Implementability is evaluated per the following factors:
 - Technical feasibility, including difficulties and unknowns associated with construction, operation, technological reliability, ease of undertaking additional remedial actions, and ability to monitor remedial effectiveness.
 - Administrative feasibility, including coordination activities, ability and time required for necessary approvals, and issuance of required permits.
 - Availability of services and materials, as applicable, including: adequate offsite treatment, storage, and disposal capacity; necessary equipment, specialists, manpower, and provisions; prospective and emerging technologies.
- **Cost.** For the detailed cost analysis of alternatives, the expenditures required to complete each measure are estimated in terms of both capital and annual O&M costs. Given these values, a present-worth calculation for each alternative can be calculated for comparison. The cost estimates in this section provide an accuracy of – 30 to +50 percent. Costs are projected for a period of 30 years or required remedial duration in accordance with *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study* (USEPA, 2000b).

Selection of specific technologies utilized in alternative configurations is not intended to limit final design options, but rather provides a baseline for cost estimation. Final cost, and resultant feasibility, depends on

actual labor and material costs, competitive market conditions, site conditions, project scope, implementation schedule, contracted design, and other variables. Due to these factors, project feasibility and funding needs must be reviewed carefully before specific financial decisions are made, to help ensure proper evaluation, budget, and adequate funding. Specific details and cost estimates may need to be refined during final remedial design, as applicable.

4.1.3 Modifying Criteria

The following criteria modify selection of recommended alternatives:

- **Community Acceptance.** This assessment includes determination of public opinion, support of, and/or opposition to components of remedial options.
- **State (Commonwealth) Acceptance.** State (commonwealth) concerns taken into consideration include the following:
 - The state’s (commonwealth’s) position and key interests related to alternatives
 - State (commonwealth) comments on ARARs (or proposed waivers)

Modifying criteria are evaluated following public comment, and as result, community and state (commonwealth) acceptance is not addressed in this FS. State (commonwealth) acceptance and community acceptance criteria will be evaluated by addressing comments received after the USEPA, EQB, and the public have reviewed site documents [e.g., Proposed Plan]. This evaluation will be presented in the Responsiveness Summary of the ROD.

The following subsections evaluate remedial alternatives against the first seven criteria described above. Sufficient detail is incorporated into the analysis to understand significant aspects of each alternative, and to identify uncertainties associated with proposed solutions. Details are presented in Tables 4-1 through 4-3 for reader-friendly side-by-side viewing of the alternatives and are not duplicated within the text. The text focuses on the key differences between the alternatives.

4.2 Detailed Evaluation of Remedial Alternatives

The three remedial alternatives were evaluated in detail using the seven evaluation criteria described in Section 4.1. The detailed evaluation is summarized in **Table 4-1**.

Detailed cost estimates of the remedial alternatives are provided in **Table 4-2**, which breaks down the estimated capital, annual O&M, and net present value (NPV), calculated based on a 3.8 percent discount rate for 30 years, as applicable. The discount rate was selected based on the Federal Office of Management and Budget (<http://www.whitehouse.gov/sites/default/files/omb/assets/a94/dischist-2012.pdf>). **Appendix C** contains detailed cost tables for each alternative. The alternative cost estimates are in 2012 dollars, based on RS Means and engineer’s estimates for similar projects.

4.3 Comparative Evaluation of Remedial Alternatives

This subsection evaluates the relative performance of each remedial alternative against the specific evaluation criteria. A semi-quantitative comparative analysis was conducted for each remedial alternative relative to one another based on each of seven NCP criteria, as shown in **Tables 4-3**. The purpose of this analysis is to score the relative advantages and disadvantages of each remedial alternative in order to support the selection of the recommended remedial alternative. The comparative analysis focuses on factors that provide distinctions between the remedial alternatives.

4.3.1 Overall Protection of Human Health and the Environment

Alternatives 2 and 3 are protective of human health and the environment because they implement LUCs to minimize the explosive safety risk associated with MEC by minimizing the potential for uncontrolled human contact with MEC potentially present and maintain land use consistent with the MOA (Navy and DOI, 2003). Alternative 3 provides a slightly higher level of protection from the explosive safety risk associated with potentially present MEC because the subsurface removal of MEC throughout the site minimizes the potential for

MEC to become exposed from soil erosion or through inadvertent excavation activities by trespassers. However, Alternative 3 requires a greater impact to the environment through vegetation clearance and land disturbance to remove subsurface MEC and has increased explosive safety risks to workers during remedy implementation without a substantial increase in protectiveness. Alternative 1 is not adequately protective of human health and the environment because its implementation would not include LUCs to minimizing the potential for uncontrolled human contact with MEC potentially present and maintain land use consistent with the MOA (Navy and DOI, 2003).

4.3.2 Compliance with ARARs

Appendix A presents a compilation and evaluation of state (Commonwealth) and federal chemical-specific, location-specific, and action-specific ARARs. Each alternative complies with the ARARs.

4.3.3 Long-Term Effectiveness and Permanence

All of the remedial alternatives result in the potential for MEC to remain at the site, and therefore require 5-Year Reviews to evaluate remedy effectiveness. Alternative 3 is most effective in long-term effectiveness and permanence because it adds the removal of MEC up to a depth of 2 ft bgs throughout the rest of the accessible areas of the site. However, the resulting improvement of long-term effectiveness and permanence is marginal. Although removal of subsurface MEC minimizes the potential for them to become exposed over time, the ability to remove the subsurface MEC is dependent upon technology to detect them. MEC removal would be conducted in accordance with the quality control requirements established in the MEC Master Work Plan for Vieques (CH2M HILL, 2006); each aspect of work will be subject to the three phases of control (Preparatory Phase, Initial Phase, and Follow-Up Phase) and quality assurance review. However, standard industry practice does not currently accept that current technologies are capable of achieving 100% removal of MEC. Therefore, LUCs are included with Alternative 3 to control potential exposure to MEC that could potentially remain after the MEC removal. The actual level of long-term protection for Alternatives 2 and 3 is relatively similar, with Alternative 3 performing slightly better due to the additional MEC removal. Alternative 2 only includes limited subsurface MEC removal in comparison to Alternative's 3 subsurface clearance of all remaining areas. Like Alternative 3, Alternative 2 includes LUCs to minimize uncontrolled exposure to MEC that potentially remain at the site and maintain land use that is consistent with the MOA (Navy and DOI, 2003), and includes monitoring to verify the effectiveness of the controls and identify changes in site conditions that may increase MEC safety risks. With this alternative, the possibility for trespassers to encounter potential MEC exists, but the potential is limited because MEC most likely to have been encountered (i.e., on the surface, along roadways, and on beaches) were removed during the removal actions previously conducted at the site (**Section 1.3.1**). Alternative 1 achieves moderate degree of long-term effectiveness because residual risk was significantly reduced through interim removal actions that removed surface MEC in all accessible areas of the site and subsurface MEC in areas of the site with highest likelihood of exposure. Although MEC remain on site, the likelihood of encountering them is low. However, the alternative does not include controls to minimize exposure to the residual risks or minimized uncontrolled human contact with potentially contaminated media that may pose unacceptable risk. Like Alternative 2, the possibility for trespassers to encounter potential MEC exists, but is limited because MEC most likely to have been encountered (i.e., on the surface, along roadways, and on beaches) were removed during the removal actions previously conducted at the site.

4.3.4 Reduction of Toxicity, Mobility, and Volume through Treatment

Alternative 3 has the greatest degree of reduction in toxicity, mobility, or volume through treatment because it includes the removal and treatment (detonation) of subsurface MEC down to 2 ft bgs or bedrock, whichever is shallower, across all accessible portions of the site, including the lagoon. Alternative 2 has a small degree of reduction in toxicity, mobility, or volume of treatment through limited subsurface MEC removal and treatment (detonation). Additionally, a significant reduction in volume of MEC occurred at the site during the previous removal actions (**Section 1.3.1**) and is factored into this overall evaluation. There would not be a reduction in toxicity, mobility, and volume through implementation of Alternative 1.

4.3.5 Short-Term Effectiveness

Alternative 2 achieves the greatest degree of short-term effectiveness, balancing protection of the community during remedial actions, protection of workers during remedial actions, environmental impacts, and the time until RAOs are achieved. Because each of these criteria varies for Alternative 2 in comparison to the other Alternatives, the short-term effectiveness is discussed for each of the sub-criterion in the following paragraphs rather than for short-term effectiveness as a whole.

Alternatives 1, 2, and 3 are similarly protective of the community. Alternative 1 has no action and therefore no impact on the community. Alternatives 2 and 3 have minimal potential impacts to the community. Each alternative includes construction of a fence along the western boundary of the LIA, but the MOV is separated from that area by the EMA so the community impact would be minimal. Additionally, fence installation is a minimally intrusive activity for which noise and dust would be negligible. Therefore, the community impact would only be a small increase in traffic through the community to bring in fence materials. The traffic impact for Alternative 3 would be greater than Alternative 2 as Alternative 3 requires more construction equipment and personnel.

Because there would be no remedial construction activities associated with Alternative 1, this alternative has the least short-term impacts. Alternative 2 would result in significantly lower construction impacts than Alternative 3 because Alternative 2 involves only the installation of only fencing and signage and limited MEC removal. Alternative 3 includes the same construction elements as Alternative 2, but adds MEC removal and construction activities over a 106-acre area. Working with potentially live munitions is the main hazard to workers. The hazard would be managed through the use of qualified personnel (e.g., UXO technicians) and implementation of applicable safety requirements for handling, storage, and demolition/demilitarization of MEC. All exclusion areas where removal is taking place would be restricted for explosive safety purposes and only authorized personnel would be allowed in the exclusion zone. Noise and potential explosive residue dust from MEC demolition/demilitarization is a short-term acute concern to the workers, but will be managed through the safety program. An additional hazard to workers during implementation is working in rough terrain in a tropical and vegetated climate, which would be mitigated through an established safety program.

Alternative 1 has the least impact on the environment because it does not include any remedial construction. Alternative 2 has a greater impact to the environment through minor clearing to facilitate fence installation and limited MEC removal. However, the temporary environmental impacts could be mitigated with standard practices shortly after completion of the action. Because significant vegetation clearance was performed to support the previous removal actions, vegetation restoration would be necessary and relatively similar for Alternatives 2 and 3. Potential impacts to the environment are significantly greater with Alternative 3 than with Alternative 2 because of the expansive (approximately 68 acres) temporary land disturbance (e.g., vegetation clearance, portions of which are unique subtropical forest, ground disturbance to remove MEC, lagoon dewatering and disturbance) included in Alternative 3. However, the temporary environmental impacts could also be mitigated with standard practices shortly after completion of the action. Because significant vegetation clearance was performed to support the previous removal actions, vegetation restoration would be necessary and relatively similar for Alternatives 2 and 3.

A sustainability analysis of the three alternatives was conducted using the SiteWise™ tool (see **Appendix B**). Alternative 2 is anticipated to have a medium environmental footprint in terms of projected GHG emissions and energy consumptions. Although it includes minimal construction activities, the travel for site inspections over the estimated 30-year LTM period prevents the alternative from achieving a low impact score. Alternative 3 is anticipated to have a significantly greater environmental footprint due to the extensive construction activities included with that alternative.

Alternative 2 could be implemented quickly after a ROD is finalized (approximately 6 months) because it is mostly administrative and only includes a minor field effort. Alternative 3 would take approximately 2 years longer to achieve protectiveness than Alternative 2 because of its extensive field effort.

4.3.6 Implementability

The implementability of Alternative 2 is the easiest because it is technically and administratively feasible and the services, equipment, and materials required for its implementation are readily available. Alternative 1 has a lower degree of implementability than Alternative 2. Although it would be technically easy to implement and requires no resources because it includes no construction activities, it is may be difficult to gain regulatory acceptance because of the MEC that are assumed to remain on site in the subsurface and the lack of means to control exposure to them. Alternative 3 is the most difficult to implement. From a technical implementability standpoint, it requires, vegetation clearance over a 59-acre area, and the manual removal of subsurface MEC over all accessible portions of the site where subsurface clearance was not conducted and bedrock is not exposed (estimated as a 68 -acre area for subsurface removal). However, the resources and technologies to implement these activities are commonly used and available.

4.3.7 Cost

Alternative 1 is the most cost effective with a present-worth cost of \$184,000, associated with the 5-Year Reviews. The present-worth cost of Alternative 2 (\$2,078,000) is greater than Alternative 1. Alternative 3, with an estimated present-worth cost of \$10,546,000, is significantly less cost-effective than Alternatives 1 and 2. The cost estimates, summarized in **Tables 4-2**, are rough order of magnitude estimates (+50 percent/-30 percent level accuracy) that have been developed strictly for comparing the remedial alternatives. The final costs of the project and the resulting feasibility will depend on actual labor and material costs, competitive market conditions, actual site conditions, final project scope, the implementation schedule, and other variables. Therefore, final project costs may vary from the cost estimates. Because of these factors, project feasibility and funding needs should be reviewed carefully before specific financial decisions are made or project budgets are established to help ensure proper project evaluation and adequate funding.

TABLE 4-1
Detailed Evaluation of Remedial Alternatives
Feasibility Study Report
UXO 1, Eastern Conservation Area
Former Vieques Naval Training Range
Vieques, Puerto Rico

Evaluation Criteria	Alternative 1	Alternative 2	Alternative 3
	No Action	LUCs and Limited MEC Removal	Subsurface MEC Removal and LUCs
Overall Protection to Human Health and the Environment			
Minimize the explosive safety risk associated with MEC by minimizing the potential for uncontrolled human contact with MEC potentially present in site soil and lagoon, and maintain land use that is consistent with the Memorandum of Agreement between the U.S. Department of Defense Properties on the Eastern End of Vieques Island.	This alternative would not meet the RAOs. Potential for human contact with MEC was significantly reduced because MEC were removed from areas with the greatest potential for exposure during interim removal actions. However, MEC are assumed to remain on site and this alternative includes no means to control access to the site, and thereby minimize uncontrolled human contact with remaining MEC. The alternative also does not include a means to confirm land use remains consistent with the Memorandum of Agreement.	This alternative would meet the RAOs because, in addition to the minimized potential for uncontrolled human contact with MEC resulting from the previous interim removal actions, it would implement LUCs to control site access, limit intrusive activities to prevent future uncontrolled human exposure, and maintain land use consistent with the Memorandum of Agreement. Unauthorized access to the site would be minimized by fencing, signage, ICs, and LTM.	This alternative would meet the RAOs because it would remove MEC that could reasonably be encountered based on the planned future site use plus implement LUCs to control site access, limit intrusive activities to minimize future uncontrolled human exposure, and maintain land use consistent with the Memorandum of Agreement. Subsurface MEC removal would reduce exposure risks across the site. Unauthorized access to the site would be minimized by fencing, signage, ICs, and LTM.
Compliance with ARARs			
Location-specific ARARs	Would comply with ARARs.	Would comply with ARARs.	Would comply with ARARs.
Action-specific ARARs	Not applicable. No action-specific ARARs.	Would comply with ARARs.	Would comply with ARARs.
Chemical-specific ARARs	Not applicable. No chemical-specific ARARs.	Not applicable. No chemical-specific ARARs.	Not applicable. No chemical-specific ARARs.
Long-Term Effectiveness and Permanence			
Magnitude of residual risks	No action would be taken; however, a significant reduction in risk already resulted from interim removal actions. Residual risks remain, but are present in areas with low likelihood of being encountered.	A significant reduction in risk already resulted from interim removal actions. Residual risks remain but would be reduced by minimizing uncontrolled human exposure to MEC and potentially contaminated media that may pose potentially unacceptable risk by LUCs, and implementing LTM to confirm their effectiveness and identify changes in site conditions.	Overall risk would be minimized by controlling exposure to MEC and potentially contaminated media that may pose potentially unacceptable risk by LUCs. Marginal additional risk reduction would occur through clearance of subsurface MEC across the site, as areas with highest likelihood of access (roads and beaches) have already been cleared.
Adequacy and reliability of controls	Access to the site is partially restricted, but LUCs to restrict access and activities are not in place and effectiveness is unknown because a monitoring program is not performed.	LUCs would reliably minimize the potential for uncontrolled human exposure to MEC and uncontrolled human contact with media that may pose unacceptable risk, and monitoring will be performed to confirm their effectiveness and identify changes in site conditions.	LUC would reliably minimize the potential for uncontrolled human exposure to MEC and human contact with potentially contaminated media that may pose potentially unacceptable risk, and monitoring would be performed to confirm their effectiveness and identify changes in site conditions.
Need for 5-year review	Because MEC remains in place, 5-year reviews would be required to evaluate the protectiveness of existing conditions.	Because MEC remains in place, 5-year reviews would be required to periodically evaluate the effectiveness and protectiveness of the remedy.	Because of the potential for MEC to remain even after the remedial action, 5-year reviews would be required to periodically evaluate the effectiveness and protectiveness of the remedy.

TABLE 4-1
Detailed Evaluation of Remedial Alternatives
Feasibility Study Report
UXO 1, Eastern Conservation Area
Former Vieques Naval Training Range
Vieques, Puerto Rico

Evaluation Criteria	Alternative 1	Alternative 2	Alternative 3
	No Action	LUCs and Limited MEC Removal	Subsurface MEC Removal and LUCs
Reduction of Toxicity, Mobility, or Volume Through Treatment			
Reduction of toxicity, mobility, or volume through treatment	No additional active remediation. Removal of MEC most likely to be encountered has already been conducted; remaining MEC would remain in place.	Limited additional active remediation. Removal and treatment (detonation) of MEC most likely to be encountered has already been conducted; remaining MEC would be removed and treated (detonation) only if identified during site inspections or if clearance of additional access pathways is necessary.	Reduction of MEC volume through removal and treatment (detonation) of subsurface MEC (down to 2 feet bgs) from the entire accessible area of site not previously addressed through the TCRA or NTCRA.
Short-Term Effectiveness			
Protection of community during remedial actions	None.	No community is located near the area where LUCs would be installed. Minimal impact to the community from traffic to transport materials to the site.	No community is located near the area where LUCs would be installed or where the subsurface removal would occur. Minimal impact to the community from traffic to transport materials and equipment to the site.
Protection of workers during remedial actions	None.	LUCs would likely require administrative resources and local co-operation. Fence and signage installation could be easily constructed with normal health and safety procedures and MEC avoidance. Limited MEC removal would follow well-established health and safety plan and procedures, with on-site UXO support, so that potential impacts to workers would be minimized.	LUCs would likely require administrative resources and local co-operation. The MEC clearance would follow well-established health and safety plan and procedure, with UXO on-site support, so that potential impacts to workers including explosive hazard, noise, and residue dust from munitions detonated would be minimized but are inherent.
Environmental impacts	None.	Minimal environmental impact due to vegetation clearing for fence installation. However, selection of the fence alignment will factor in clearing requirements, and vegetation will be allowed to regrow.	Significant temporary disturbance of land would occur during construction activities (i.e., vegetation clearance, MEC clearance, lagoon dewatering, erosion control, and re-vegetation. Lagoon habitat will be impacted but has demonstrated a tolerance to drastic changes in water level and is expected to become naturally restored).
Time until RAOs are achieved	Not achieved.	Approximately 6 months to control of risks with implementation of LUCs and LTM.	Approximately 1 year of planning and 1 year for completion of MEC clearance activities after completion of planning. Approximately 6 months to control of risks due to implementation of LUCs and LTM.
Environmental Footprint (In terms of greenhouse gas [GHG] emissions and energy consumption)	Low. (Estimated 8 metric tons GHG)	Medium. (Estimated 143 metric tons GHG)	High. (Estimated 252 metric tons GHG)

TABLE 4-1
Detailed Evaluation of Remedial Alternatives
Feasibility Study Report
UXO 1, Eastern Conservation Area
Former Vieques Naval Training Range
Vieques, Puerto Rico

Evaluation Criteria	Alternative 1	Alternative 2	Alternative 3
	No Action	LUCs and Limited MEC Removal	Subsurface MEC Removal and LUCs
Implementability			
Technical feasibility	No technical issues.	Services and materials are available and easily implementable.	Significant technical challenge for lagoon dewatering and vegetation clearance.
Administrative feasibility	Agency approval more involved. Unlikely to achieve administrative acceptance.	Feasible.	Feasible. Would likely involve substantive erosion control requirements (best management practices) due to disturbance of land.
Availability of services, equipment, and materials	None required.	Readily available.	Readily available.
Cost			
(See Table 4-2 for Cost Breakdown)	Low.	Moderately low.	Extremely High.

TABLE 4-2

Summary of Cost Estimates

Feasibility Study Report

UXO 1, Eastern Conservation Area

Former Vieques Naval Training Range

Vieques, Puerto Rico

Alternative	Alternative 1 No Action	Alternative 2 Limited MEC Removal and LUCs	Alternative 3 Subsurface MEC Removal and LUCs
Total Capital Cost	\$0	\$511,000	\$8,979,000
Total O&M and Periodic Cost (NPV)	\$184,000	\$1,567,000	\$1,567,000
<i>LTM</i>	<i>\$0</i>	<i>\$1,383,000</i>	<i>\$1,383,000</i>
<i>5-Year Reviews</i>	<i>\$184,000</i>	<i>\$184,000</i>	<i>\$184,000</i>
Total Project Cost (NPV in 2012 \$)	\$184,000	\$2,078,000	\$10,546,000

Notes:

NPV is calculated based on the Federal Office of Management and Budget discount rate (<http://www.whitehouse.gov/sites/default/files/omb/assets/a94/dischist-2012.pdf>).

Cost estimates are rough order of magnitude estimates, with an accuracy of +50%/-30%.

TABLE 4-3

Comparative Analysis of Remedial Alternatives

Feasibility Study Report

UXO 1, Eastern Conservation Area

Former Vieques Naval Training Range

Vieques, Puerto Rico

Criterion	Alternative 1	Alternative 2	Alternative 3
	No Action	LUCs and Limited MEC Removal	Subsurface MEC Removal and LUCs
Threshold Criterion			
Overall protection of human health and the environment			
Compliance with ARARs			
Compliance with Chemical-Specific ARARs			
Compliance with Action-Specific ARARs			
Compliance with Location-Specific ARARs			
Balancing Criterion			
Long-term effectiveness and permanence			
Magnitude of Residual Risk			
Adequacy and Reliability of Controls			
Reduction of toxicity, mobility, or volume through treatment			
Treatment Process Used and Materials Treated			
Amount of Hazardous Materials Destroyed or Treated	Not Applicable		
Degree of Expected Reductions in Toxicity, Mobility, and Volume	Not Applicable		
Degree to Which Treatment is Irreversible	Not Applicable		
Type and Quantity of Residual Remaining After Treatment	Not Applicable		
Short-term effectiveness			
Protection of Community During Remedial Actions			
Protection of Workers During Remedial Actions			
Environmental Impacts			
Time Until Remedial Action Objectives are Achieved			
Implementability			
Technical Feasibility			
Administrative Feasibility			
Availability of Services, Equipment, and Materials			
Cost (Total Present Value)	\$ 184,000	\$ 2,078,000	\$ 10,546,000

Individual criterion scores: ○ not met ◐ poor ◑ satisfactory ◒ good ● excellent

SECTION 5

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Appendix A
Applicable or Relevant and Appropriate
Requirements

TABLE A-1

Federal Chemical-Specific ARARs

Feasibility Study Report

UXO 1, Eastern Conservation Area

Former Vieques Naval Training Range

Vieques, Puerto Rico

Media	Requirement	Prerequisite	Citation	Alternative	ARAR Determination	Comment
No Federal Chemical-Specific ARARs apply.						

TABLE A-2

Puerto Rico Chemical-Specific ARARs

Feasibility Study Report

UXO 1, Eastern Conservation Area

Former Vieques Naval Training Range

Vieques, Puerto Rico

Media	Requirement	Prerequisite	Citation	Alternative	ARAR Determination	Comment
No Puerto Rico Chemical-Specific ARARs apply.						

Table A-3

Federal Location-Specific ARARs

Feasibility Study Report

UXO 1, Eastern Conservation Area

Former Vieques Naval Training Range

Vieques, Puerto Rico

Location	Requirement	Prerequisite	Citation	Alternative	ARAR Determination	Comment
Coastal Zone Management Act						
Coastal zone or area that will affect the coastal zone	Federal activities must be consistent with, to the area that will affect maximum extent practicable, State coastal zone management programs. Federal agencies must supply the State with a consistency determination.	Activity taking place in a wetland, flood plain, estuary, beach, dune, barrier island, coral reef, and fish and wildlife and their habitat, within the coastal zone.	15 CFR 930.33(a)(1), (a)(2), (b); .35(a), (b); .36(a)	All	Applicable	Activities at UXO 1 that will affect Puerto Rico's coastal zone will be consistent to the maximum extent practicable with Puerto Rico's enforceable policies. Activities performed on-site and in compliance with CERCLA are not subject to administrative review; however, the substantive requirements of making a consistency determination will be met.
Migratory Bird Treaty Act						
Migratory bird area	Protects almost all species of native birds in the United States from unregulated taking.	Presence of migratory birds.	Migratory Bird Treaty Act, 16 USC 703	All	Applicable	The site is located in the Atlantic Americas Migratory Flyway. If migratory birds, or their nests or eggs, are identified at the site, operations will not destroy the birds, nests, or eggs.
Endangered Species Act 1978						
Endangered Species	Actions to protect endangered or threatened species and prevent adversely impacting critical habitat.	Presence of protected species or their critical habitat	16 USC 1538(a)(1)(B)	All	Applicable	Several endangered species and critical habitat have been identified at UXO1. If protected species are present at the site during the response action, steps will be taken to prevent adverse impacts. Activities will avoid identified critical habitat areas or, if they cannot be avoided, actions resulting in permanent impact will be avoided.
Archaeological Resources Protection Act of 1979						
Locations of Archaeological Significance	Provides for the preservation of historically and archaeologically significant artifacts.	Applies to archaeological sites and artifacts.	16 USC 470ee(a)	All	Applicable	Archaeological sites have been identified within the UXO1 boundary. Activities will avoid these sites to the maximum extent practical. Activities performed on-site and in compliance with CERCLA are not subject to permits or administrative review; however, the substantive requirements of a permit to disturb these sites will be met if they cannot be avoided.

Table A-4

Puerto Rico Location-Specific ARARs

Feasibility Study Report

UXO 1, Eastern Conservation Area

Former Vieques Naval Training Range

Vieques, Puerto Rico

Location	Requirement	Prerequisite	Citation	Alternative	ARAR Determination	Comment
No Puerto Rico Location-Specific ARARs apply.						

Table A-5

Federal Action-Specific ARARs
Feasibility Study Report
UXO 1, Eastern Conservation Area
Former Vieques Naval Training Range
Vieques, Puerto Rico

Action	Requirement	Prerequisite	Citation	Alternative	ARAR Determination	Comment
Performing activities that will disturb greater than one acre of land	Requires the development and implementation of best management practices and erosion and sedimentation control measures during construction activity.	Implementation of construction activities that will disturb more than one acre of land	one to five acres: 40 CFR 122.26(a)(1)(ii), (a) (9)(i)(b), (b)(15); 122.44(k)(2) and (s)(1) five acres or more: 40 CFR 122.26(a)(1)(ii), (a)(9)(i)(b), (b)(14)(x); 122.44(k)(2) and (s)(2)	2, 3	Applicable	If the selected remedy disturbs greater than one acre of land a Storm Water Pollution Prevention Plan will be prepared and implemented. Since activities are taking place on site and in compliance with CERCLA, the substantive requirements will be met, but a permit will not be required.
Management of military munitions	Specifies management requirements for those military munitions that are no longer exempt from the definition of solid waste	Management of unused military munitions that have been disposed of or fired/used military munitions that have been removed from the range.	40 CFR 266.202(b) and (c) ; 205 (a) and (b)	2, 3	Applicable	If any military munitions lose their exemption from the definition of solid waste they will be handled in accordance with these rules.

Table A-6

Puerto Rico Action-Specific ARARs

Feasibility Study Report

UXO 1, Eastern Conservation Area

Former Vieques Naval Training Range

Vieques, Puerto Rico

Action	Requirement	Prerequisite	Citation	Alternative	ARAR Determination	Comment
Land disturbance	A Control of Erosion and Sediment (CES) Plan and a Work Plan must be prepared for any activities that involve the alteration of ground or soil conditions that have not been specifically excluded.	Disturbance of more than 40 cubic meters of soil during construction activity	Puerto Rico Regulation 5754.1230(B), (C)	2, 3	Applicable	Remedial alternatives involve the disturbance of more than 40 cubic meters of soil. A CES and Work Plan will be prepared for this activity.
Production of Fugitive Dust	Dust control measures must be implemented during construction activities to prevent emissions beyond the property boundary. These include, but are not limited to, the use of water or other chemicals on road ways to control dust, covering haul trucks, and cleaning tracked soil off of paved roads.	Construction activity causing particulate matter to become airborne	Puerto Rico Regulation 5300.404(A)(2), (4), (7); (B)	2, 3	Applicable	Applicable to activities that produce fugitive dust. Dust control measures will be implemented.
Performing construction activities that generate noise	No construction activity may be performed at night or in such a way that vibrations are produced that can be felt beyond the property boundary. If equipment used in construction is not manufactured in accordance with USEPA standards for newly manufactured equipment then it may not produce noise that exceeds 70	Construction activity including earthwork	Puerto Rico Regulation 3418.26	2, 3	Applicable	The site is considered to be in Zone II (Commercial) for noise production. Noise pollution during MEC clearance and demolition, dewatering, and earthwork activities will be prevented.
Management of non-hazardous solid waste onsite in containers and piles	Non-hazardous solid waste staged onsite must not create a hazard or public nuisance.	Generation of non-hazardous solid waste that is managed onsite in containers or in piles.	Puerto Rico Non-Hazardous Solid Waste Regulation 531.H	2, 3	Applicable	It is anticipated that non-hazardous solid wastes will be generated during the implementation of these alternatives. IDW will be sampled to confirm characterization prior to disposal. It will be assumed that MDAS is regulated as scrap metal.
Surface water discharge	Sets surface water standards for receiving waters.	Discharging of surface water from the lagoon to adjacent surface water body	Rule 1303C, 1303.1A, B, D, E, and H	3	Applicable	Applicable to surface water discharges associated with dewatering the lagoon. Investigation did not identify COCs in surface water; therefore, it is assumed that existing concentrations of any substances are equivalent to background and further testing is not required.

Appendix B
Sustainability Analysis

Sustainability Analysis for UXO-1

Introduction

This appendix presents the approach taken and results obtained from a sustainability analysis performed for Site UXO 1, Eastern Conservation Area, Vieques, Puerto Rico. A site description and history of UXO 1 is provided in Section 1 of the Feasibility Study (FS).

Remedial alternatives were developed to address the munitions and explosives of concern (MEC) in the subsurface at UXO 1. A detailed summary of the remedial alternatives is provided in Section 3 of the FS. A sustainability analysis was performed using SiteWise™ Version 2.0 (Battelle, 2011) for the following remedial alternatives:

- Alternative 1 - No Action
- Alternative 2 – Limited MEC Removal and Land use controls (LUCs)
- Alternative 3 – Subsurface MEC Removal and LUCs

Method and Assumptions

The SiteWise™ tool consists of a series of Excel-based spreadsheets used to conduct a baseline assessment of sustainability metrics. The assessment is carried out using a spreadsheet-based building block approach, where every remedial alternative is first broken down into modules that mirror the phases of remedial action work, specifically: remedial investigation (RI), remedial action construction (RAC), remedial action operation (RAO), and long-term monitoring (LTM). For this analysis only the RAC and LTM phases were applicable.

SiteWise™ uses various emission factors from governmental or non-governmental research sources to determine the environmental impact of each activity. The quantitative metrics calculated by the tool include:

- 1) Greenhouse gases (GHGs) reported as carbon dioxide equivalents (CO₂e), consisting of carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O)
- 2) Energy usage (expressed as British Thermal Units [BTU])
- 3) Water usage (gallons of water)
- 4) Air emissions of criteria pollutants consisting of nitrogen (NO_x), sulfur oxides (SO_x), and particulate matter (PM₁₀)
- 5) Accident risk (risk of injury and risk of fatality)

For the purpose of this discussion the term footprint will be used to describe the quantified emissions or quantities for each metric. To estimate the sustainability footprint for each remedial alternative, only those elements possessing important sustainability elements were included in the assessment. The first four metrics are collectively referred to as the environmental footprint. The footprints of each remedial phase are combined into overall footprints for each remedial action.

A lower footprint indicates lower deleterious impacts to environmental and social metrics, which collectively make up the SiteWise™ sustainability metrics. Conversely, a higher footprint indicates higher deleterious impacts associated with the SiteWise™ metrics. The major conclusions of this sustainability analysis are incorporated into the short-term effectiveness criteria evaluation of the FS.

The following is a description of the major activities for each alternative covered under each remedial action phase.

- RAC: Transportation of personnel (road, air, and water) and equipment for construction efforts involving vegetation removal, MEC removal, establishing IC/LUC (including fencing), and onsite labor.

- Alternative 1 has no actions under this phase.
 - Alternative 2 involves establishing IC/LUCs (including fencing), surveying, minor vegetation clearance, and limited MEC removal (e.g., along the LUC boundary and in select areas to support access, plant trees, and manage land). Daily transportation and onsite labor hours for LUC installation and MEC removal, along with transportation of scrap to a local landfill are also considered in this phase.
 - Alternative 3 involves establishing IC/LUCs, and subsurface MEC removal which requires vegetation clearing over 57 acres of dry land area, dewatering a 9-acre lagoon (electricity to power the pump during dewatering activities), daily transportation and onsite labor hours for MEC removal, and scrap transportation to a local landfill.
- LTM: Transportation of personnel for five-year-review site visits and inspections (all alternatives), 2 annual inspections (one regularly scheduled and one after a major storm event) for erosion and fencing and limited MEC removal (for Alternatives 2 and 3 only).

General Assumptions

The specific assumptions made for the individual remedies are presented in **Tables B-1** through **B-3**. The following overall assumptions are used for the SiteWise™ tool evaluation:

- The complete environmental footprint for production of equipment used, or production of the vehicles used for transportation, is not considered in this analysis.
- For materials being shipped onsite (i.e. fencing), the transportation of these materials was captured using the EQUIPMENT TRANSPORTATION sections.
- Personnel transportation to Vieques at the beginning of field efforts is assumed to originate in Atlanta, Georgia, and consists of 3,000 air miles to the site for all onsite personnel.
- Local transportation is assumed to consist of 25 miles of driving a sport utility vehicle (SUV) per day.
- Transportation is assumed to be shared (2 to 3 people per vehicle as specified in **Table B-1** through **B-3**).

Results and Conclusions

The overall quantitative footprints for each alternative are provided in along with the relative impact of each alternative in each footprint (**Table B-4**). The relative impact is a qualitative assessment of the relative footprint of each alternative, a rating of high, medium, or low is assigned to each alternative based on its performance against the other alternatives. The tool assigns a ranking of high to the highest footprint in each category and assigns the rankings of other alternatives based on the difference in the data between alternatives. The ranking is based on a 30 percent difference, if the footprints of two alternatives are within 30 percent of each other they will be given the same rating and there is essentially no difference between the alternatives. This allows for some uncertainty inherent in the assumptions used in the model.

It should be noted that while this analysis compares the environmental footprints of each of the alternatives, the alternatives provide different end-uses. Therefore, a comparison of the results of the alternatives needs to be made in the context of the benefits (e.g., ARAR compliance, contaminant reduction, cost effectiveness, and etc.) of each of the alternatives.

A comparative analysis for MEC Alternatives 1, 2, and 3 is summarized in **Figure B-1**. **Table B-4** presents a comparison of the quantitative environmental footprint metrics evaluated for each of the remedial alternatives. Overall, Alternative 3 had the largest footprint for all categories and was given a “High” relative rank for all categories. The footprints for GHG emissions, total energy, NO_x, PM₁₀, and SO_x footprints for Alternative 2 were given a rank of “Medium” because they were within 30 to 70 percent of the maximum footprints. Although the RAC-phase GHG and total energy footprints for Alternative 2 were less than 30 percent of the RAC-phase footprints for Alternative 3, the LTM footprints were identical and accounted for the majority of Alternative 2 and approximately one-half of the total footprints for Alternative 3, causing the overall difference to be within the 30

to 70 percent range. All footprints for Alternative 1 were given a “Low” rank because they were less than 30 percent of the maximum footprint. This is because each alternative incorporates all of the activities of the previous alternative and is progressively more labor and material intensive. As previously discussed, a smaller footprint is more desirable. The footprints for each alternative are discussed below.

- **Alternative 1— No Action**
Transportation of personnel (five-year review inspections) was the only activity contributing to the environmental footprint for Alternative 1. Water use was considered negligible for onsite activities. Onsite labor hours and transportation are included in the accident risk fatality and accident risk injury footprints and labor contributed to over half of the accident risk fatality footprint and the majority of the accident risk injury footprint. Results are provided in **Table B-5** and **Figure B-2**.
- **Alternative 2 – Limited MEC Removal and LUCs**
Similar to Alternative 1, transportation of personnel during the LTM phase (annual and five-year review inspections) accounted for the majority of the environmental footprints. Water use was considered negligible and not included. The GHG and total energy footprint of steel production for the fence was included under the RAC phase and contributed to approximately 15 to 20 percent of the total RAC footprints for GHG and total energy. SiteWise™ does not include additional impacts (NO_x, SO_x, PM₁₀, or water) for manufacture of materials so the footprints may be underestimated. Onsite labor hours accounted for the majority of accident risk fatality and injury footprints. Results are provided in **Table B-6** and **Figure B-3**.
- **Alternative 3 – Subsurface MEC Removal and LUCs**
Transportation during the MEC removal activities (RAC phase) contributed to approximately 50 to 65 percent of the overall environmental footprints. Electricity use to power the dewatering pumps was the only contributor to the water consumption footprint (cooling water during electricity production). Electricity use for dewatering and equipment use during vegetation clearing also contributed approximately 20 to 25 percent of the total SO_x and PM₁₀ footprints. Onsite labor hours contributed to the majority of the accident risk injury and fatality footprints. Results are provided in **Table B-7** and **Figure B-4**.

Uncertainty Assessment

An electricity mix for Puerto Rico was unavailable; an electricity mix for Florida was used to estimate the impacts from electricity use.

SiteWise™ does not include water consumption, NO_x, SO_x, and PM₁₀ footprints for material manufacturing, these categories may be underestimated if material use is intensive.

Impacts from explosives used for demolition of MEC are not available in SiteWise™. It can be assumed that the alternative using the highest volume of explosives will have the largest relative footprint from the explosives.

Recommendations

The estimates from the SiteWise™ tool were used to estimate the environmental footprint of the alternatives. Once the alternative is selected, it is recommended that the footprint of the selected alternative be further evaluated in the design phase of the projects to explore opportunities to optimize the environmental footprint of the project and integrate sustainable remediation best practices in the design, construction, and operation of the alternative. In this evaluation, the majority of the environmental footprints (all impact categories except accident risks) were from transportation, primarily air travel. While it may not always be feasible to use alternative transportation modes, limiting the number of flights or selecting local labor when possible could alleviate some of the environmental burdens.

References

Battelle. 2011. *SiteWise™ Version 2 User Guide*. NAVFAC Engineering Service Center, UG-2092-ENV. June.

TABLE B-1

Alternative 1 - No Action

Feasibility Study Report

UXO 1, Eastern Conservation Area

Former Vieques Naval Training Range

Vieques, Puerto Rico

Phase	Assumptions
Remedial Action Construction	No Actions
Longterm Monitoring	Five-year Review
Labor Hours Onsite - operating engineer	240 hours (30 years, site visit every 5 years, two 10-hr days, two people)
Personnel Transportation	Five-year Review air travel to Vieques - 3,000 miles per person per event (R/T), 2 people x 6 events = 12 flights total
	Local travel - 2 people, 25 miles per day, 2 days per event x 6 events = 12 trips, assume gasoline powered SUV, shared vehicle

Notes:

R/T = round trip

TABLE B-2

Alternative 2 - Limited Munitions and Explosives of Concern (MEC) Removal and Land Use Controls (LUCs)

Feasibility Study Report

UXO 1, Eastern Conservation Area

Former Vieques Naval Training Range

Vieques, Puerto Rico

Sitewise Tab	Assumptions
Remedial Action Construction	Limited MEC Removal, Survey, Land Use Controls, Oversight, Fence Installation
Labor Hours Onsite	140 hours for MEC Removal (7 people [Site Manager, SUXOS, Administrative, 4 UXO techs] 10 hrs/day x 2 days onsite) Note: UXO tech assumed equivalent risk as "Construction Laborer in SiteWise" (80 hours), all other labor assumed to be equivalent to "Operating Engineer"
	300 hours (6 people 5 x 10-hr days) - LUC/IC implementation
Materials (Fencing)	2,610 ft of 2-wire fencing with 7 ft tall fence posts at 8-ft intervals = approximately 330 posts, 10 lbs each = 3,300 lbs steel
Personnel Transportation - Air	MEC Removal - 7 people, 3,000 miles per person, 2 events = 14 flights LUC/IC field crew - 6 people, 3,000 miles per person, 1 event = 6 flights
Personnel Transportation - Road	Local travel - 2 days, 25 miles per day, 7 people, 3 shared vehicles (2, 2, and 3 people per vehicle) = approx. 6 trips Local travel LUC/IC - 5 days, 25 miles per day, 6 people, 2 shared vehicles = 15 total trips
Material and Equipment Transportation	Equipment (vegetation clearance) and fencing = approximately 20 tons total, assume available in San Juan, 100 road miles and 50 water miles to site
Equipment Use	Vegetation clearance - assume Internal Combustion Engine with a consumption rate of 1.3 gallons (diesel) per hour (similar to 65 hp loader in SiteWise lookup Table 3b), 4 hours to clear fence path
Residual handling	Scrap (MD and other) - 2 tons total, transported 15 miles one way (1 full, 1 empty trip)
Longterm Monitoring	Annual Inspections, Limited MEC Removal, Five-year Review
Labor Hours Onsite	3,840 hours (30 years, 2 events per year of LTM, 2 x 10-hr days, 3 people, plus 240 hours from 5 year review)
Personnel Transportation - Air	LTM air travel to Vieques (2 trips/year)- 3,000 miles per person per event (R/T), 3 people, x 60 events = 180 flights total Five-year Review air travel to Vieques - 3,000 miles per person per event (R/T), 2 people x 6 events = 12 flights total
Personnel Transportation - Roads	Local travel annual Site Inspection - 3 people, 25 miles per day, 2 days per event x 60 events = 120 trips, assume gasoline powered SUV, shared vehicle Local travel Five-year Review - 2 people, 25 miles per day, 2 days per event x 6 events = 12 trips, assume gasoline powered SUV, shared vehicle
Residual handling	Scrap (MD and other) - 1 ton per year, transported 15 miles one way (30 full, 30 empty trips)

Notes:

R/T = round trip

TABLE B-3

Alternative 3 - Subsurface MEC Removal and LUCs

Feasibility Study Report

UXO 1, Eastern Conservation Area

Former Vieques Naval Training Range

Vieques, Puerto Rico

Sitewise Tab	Assumptions
Remedial Action Construction	MEC Removal, LUC/IC Implementation
Labor Hours Onsite	28,800 hours for MEC Removal (12 people [Site Manager, 2 UXO oversight, 1 admin, 8 UXO techs] 50 hrs/week x 4 weeks/month x 12 months) Note: UXO tech assumed equivalent risk as "Construction Laborer in SiteWise" (19,200 hours), all other labor assumed to be equivalent to "Operating Engineer"
	300 hours (6 people 5 x 10-hr days) - LUC implementation
Materials (Fencing)	2,610 ft of 2-wire fencing with 7 ft tall fence posts at 8-ft intervals = approximately 330 posts, 10 lbs each = 3,300 lbs steel
Personnel Transportation - Air	MEC Removal Personnel to Vieques (monthly trips plus one additional = 13 trips per person) - 3,000 miles, 156 total flights
	LUC/IC field crew - 6 people, 3,000 miles per person, 1 event = 6 flights
Personnel Transportation - Road	Local travel MEC Removal - 260 workdays, 25 miles per day, 12 people, 3 people per vehicle = 1,040 trips
	Local travel LUC/IC - 5 days, 25 miles per day, 6 people
Material and Equipment Transportation	Equipment (vegetation clearance) and fencing = approximately 20 tons total, assume available in San Juan, 100 road miles and 50 water miles to site
Equipment Use	Vegetation clearance - assume Internal Combustion Engine with a consumption rate of 1.3 gallons (diesel) per hour (similar to 65 hp loader in SiteWise lookup Table 3b). Assume approximately 5 acres cleared per 8-hr day, 57 acres for MEC Clearance = 90 hours. 4 hours to clear fence path. 94 hours total
	Lagoon dewatering - running equivalent of a 20 hp pump operating 24 hrs/day x 20 days = 480 hrs
Residual handling	Scrap (MD and other) - 114 tons total, transported 15 miles in 19 ton loads (6 trips full/empty)
Longterm Monitoring	Annual Inspections, Limited MEC Removal, Five-year Review
Labor Hours Onsite	3,840 hours (30 years, 2 events per year of LTM, 2 x 10-hr days, 3 people, plus 240 hours from 5 year review)
Personnel Transportation - Air	LTM air travel to Vieques (2 trips/year)- 3,000 miles per person per event (R/T), 3 people, x 60 events = 180 flights total Five-year Review air travel to Vieques - 3,000 miles per person per event (R/T), 2 people x 6 events = 12 flights total
Personnel Transportation - Roads	Local travel annual Site Inspection - 3 people, 25 miles per day, 2 days per event x 60 events = 120 trips, assume gasoline powered SUV, shared vehicle Local travel Five-year Review - 2 people, 25 miles per day, 2 days per event x 6 events = 12 trips, assume gasoline powered SUV, shared vehicle
Residual handling	Scrap (MD and other) - 1 ton per year, transported 15 miles one way (30 full, 30 empty trips)

Notes:

R/T = round trip

TABLE B-4

Relative Impact of Alternatives

Feasibility Study Report

UXO 1, Eastern Conservation Area

Former Vieques Naval Training Range

Vieques, Puerto Rico

Remedial Alternatives	GHG Emissions	Total energy Used	Water Used	NO _x emissions	SO _x Emissions	PM10 Emissions	Accident Risk Fatality	Accident Risk Injury
	metric ton	MMBTU	gallons	metric ton	metric ton	metric ton		
Alternative 1- No Action	7.8	104	0	2.13E-02	2.09E-03	1.42E-04	2.11E-05	5.90E-03
Alternative 2 - Limited MEC Removal and LUCs	143	1900	0	3.77E-01	3.69E-02	2.55E-03	3.71E-04	9.89E-02
Alternative 3 - Subsurface MEC Removal and LUCs	252	3354	3651	6.49E-01	7.35E-02	5.80E-03	3.28E-03	8.07E-01

Remedial Alternatives	GHG Emissions	Total energy Used	Water Used	NO _x emissions	SO _x Emissions	PM10 Emissions	Accident Risk Fatality	Accident Risk Injury
Alternative 1- No Action	Low	Low	Low	Low	Low	Low	Low	Low
Alternative 2 - Limited MEC Removal and LUCs	Medium	Medium	Low	Medium	Medium	Medium	Low	Low
Alternative 3 - Subsurface MEC Removal and LUCs	High	High	High	High	High	High	High	High

The relative impact is a qualitative assessment of the relative footprint of each alternative, a rating of High for an alternative is assigned if it is at least 70 percent of the maximum footprint, a rating of Medium is assigned if it is between 30 and 70 percent of the maximum footprint, and a rating of Low is assigned if it is less than 30 percent of the maximum footprint.

Notes:

MMBTU - million British Thermal Unit

NO_x - Nitrogen Oxides

SO_x - Sulfur Oxides

LUCs - land use controls

PM10 - Particulate Matter

GHG - Greenhouse Gases

MEC - munitions and explosives of concern

TABLE B-5

Alternative 1 - No Action Results

Feasibility Study Report

UXO 1, Eastern Conservation Area

Former Vieques Naval Training Range

Vieques, Puerto Rico

Phase	Activities	GHG Emissions	Total Energy Used	Water Used	NO _x Emissions	SO _x Emissions	PM ₁₀ Emissions	Accident Risk Fatality	Accident Risk Injury
		metric ton	MMBTU	gallons	metric ton	metric ton	metric ton		
Longterm Monitoring	Consumables	0	0	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	8	104	NA	2.13E-02	2.09E-03	1.42E-04	8.28E-06	3.78E-04
	Transportation-Equipment	0	0	NA	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Equipment Use and Misc	0	0	0	0.00E+00	0.00E+00	0.00E+00	1.28E-05	5.52E-03
	Residual Handling	0	0	NA	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Sub-Total	8	104	0	2.13E-02	2.09E-03	1.42E-04	2.11E-05	5.90E-03
Total		8	104	0	2.13E-02	2.09E-03	1.42E-04	2.11E-05	5.90E-03

Notes:

MMBTU - million British Thermal Unit

NO_x - Nitrogen Oxides

SO_x - Sulfur Oxides

PM10 - Particulate Matter

NA - Not Applicable

GHG - Greenhouse Gases

TABLE B-6

Alternative 2 - Limited MEC Removal and LUCs Results

Feasibility Study Report

UXO 1, Eastern Conservation Area

Former Vieques Naval Training Range

Vieques, Puerto Rico

Phase	Activities	GHG Emissions	Total Energy Used	Water Used	NO _x Emissions	SO _x Emissions	PM ₁₀ Emissions	Accident Risk Fatality	Accident Risk Injury
		metric ton	MMBTU	gallons	metric ton	metric ton	metric ton		
Remedial Action Construction	Consumables	4	49	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	13	174	NA	3.55E-02	3.48E-03	2.37E-04	1.46E-05	6.92E-04
	Transportation-Equipment	0	3	NA	6.11E-05	1.08E-06	5.43E-06	7.80E-07	6.28E-05
	Equipment Use and Misc	0	1	0	4.55E-04	5.37E-06	4.13E-05	1.05E-05	3.22E-03
	Residual Handling	0	1	NA	1.34E-05	2.38E-07	1.20E-06	2.34E-07	1.88E-05
	Sub-Total	17	227	0	3.60E-02	3.49E-03	2.85E-04	2.61E-05	3.99E-03
Longterm Monitoring	Consumables	0	0	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	124	1657	NA	3.40E-01	3.34E-02	2.23E-03	1.32E-04	6.04E-03
	Transportation-Equipment	0	0	NA	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Equipment Use and Misc	0	0	0	0.00E+00	0.00E+00	0.00E+00	2.05E-04	8.83E-02
	Residual Handling	1	17	NA	4.01E-04	7.09E-06	3.56E-05	7.02E-06	5.65E-04
Sub-Total	125	1,673	0	3.41E-01	3.34E-02	2.26E-03	3.45E-04	9.49E-02	
Total		143	1900	0	3.77E-01	3.69E-02	2.55E-03	3.71E-04	9.89E-02

Notes:

MMBTU - million British Thermal Unit

NO_x - Nitrogen OxidesSO_x - Sulfur OxidesPM₁₀ - Particulate Matter

NA - Not Applicable

GHG - Greenhouse Gases

TABLE B-7

Alternative 3 - Subsurface MEC Removal and LUCs Results

Feasibility Study Report

UXO 1, Eastern Conservation Area

Former Vieques Naval Training Range

Vieques, Puerto Rico

Phase	Activities	GHG Emissions	Total Energy Used	Water Used	NO _x Emissions	SO _x Emissions	PM ₁₀ Emissions	Accident Risk Fatality	Accident Risk Injury
		metric ton	MMBTU	gallons	metric ton	metric ton	metric ton		
Remedial Action Construction	Consumables	4	49	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	116	1534	NA	2.90E-01	2.83E-02	2.55E-03	6.63E-04	4.95E-02
	Transportation-Equipment	0	3	NA	6.11E-05	1.08E-06	5.43E-06	7.80E-07	6.28E-05
	Equipment Use and Misc	6	91	3651	1.74E-02	1.17E-02	9.71E-04	2.27E-03	6.62E-01
	Residual Handling	0	4	NA	9.37E-05	1.66E-06	8.34E-06	1.40E-06	1.13E-04
	Sub-Total	126	1,681	0	3.08E-01	4.01E-02	3.54E-03	2.94E-03	7.12E-01
Longterm Monitoring	Consumables	0	0	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	124	1657	NA	3.4E-01	3.3E-02	2.2E-03	1.3E-04	6.0E-03
	Transportation-Equipment	0	0	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0	0	0.00	0.0E+00	0.0E+00	0.0E+00	2.1E-04	8.8E-02
	Residual Handling	1	17	NA	4.0E-04	7.1E-06	3.6E-05	7.0E-06	5.7E-04
	Sub-Total	125	1,673	0	3.41E-01	3.34E-02	2.26E-03	3.45E-04	9.49E-02
Total		252	3354	0	6.49E-01	7.35E-02	5.80E-03	3.28E-03	8.07E-01

Notes:

MMBTU - million British Thermal Unit

NO_x - Nitrogen OxidesSO_x - Sulfur OxidesPM₁₀ - Particulate Matter

NA - Not Applicable

GHG - Greenhouse Gases

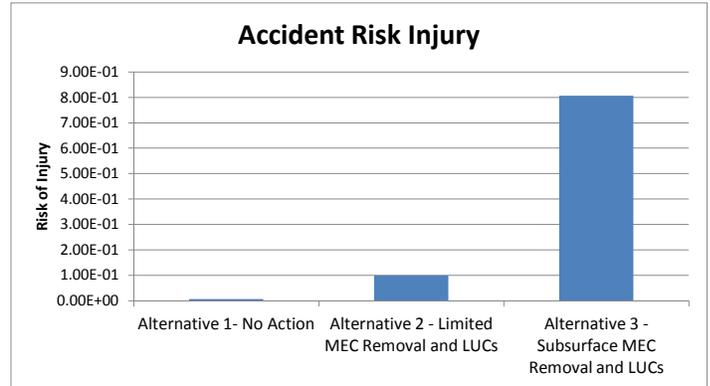
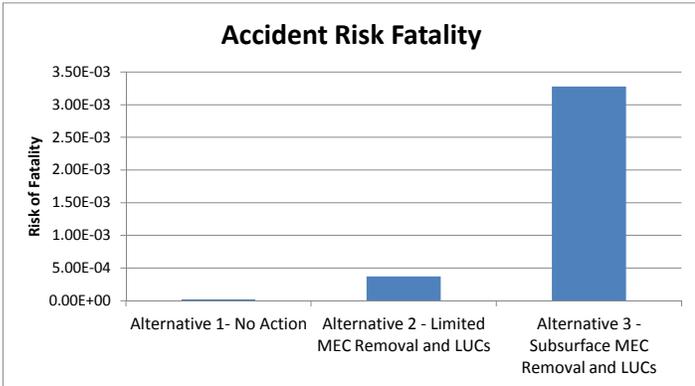
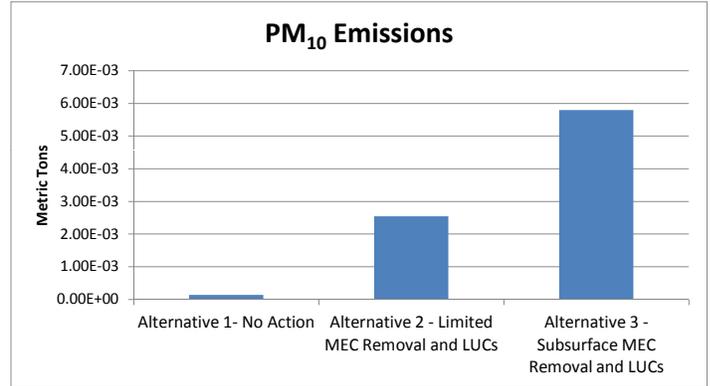
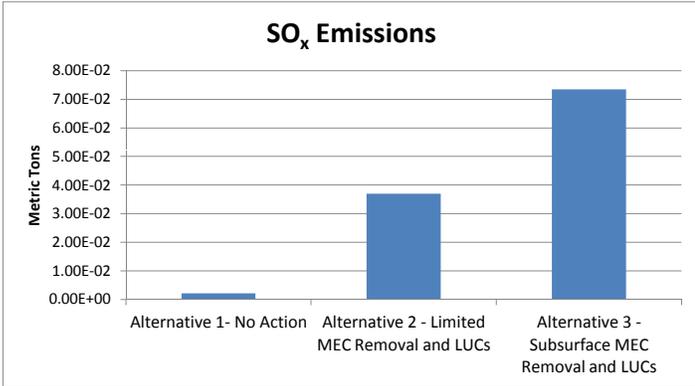
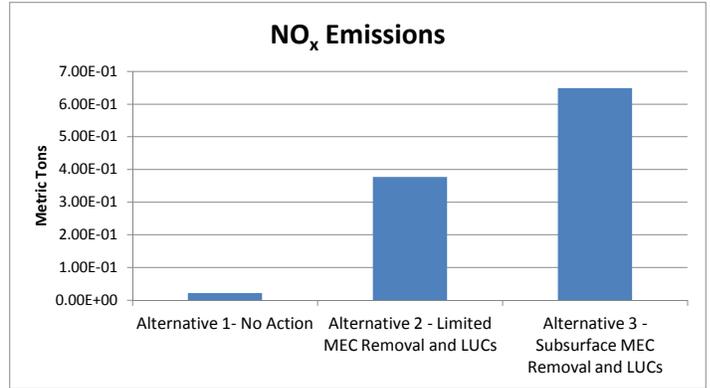
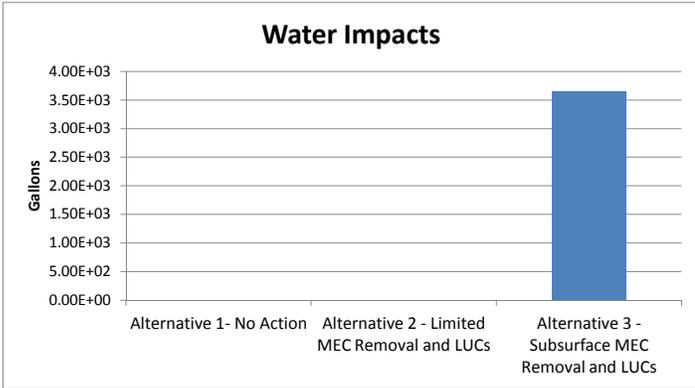
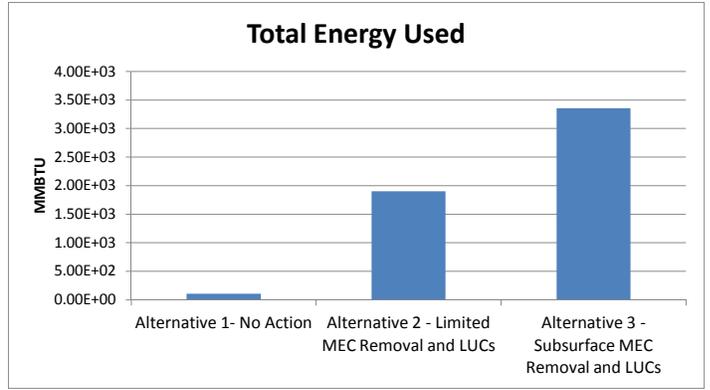
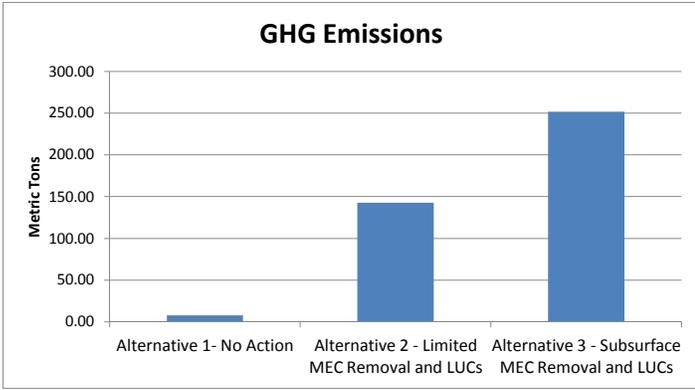


Figure B-1
 Summary of Results
 UXO 1, Eastern Conservation Area
 Feasibility Study Report
 Former Vieques Naval Training Reserve
 Vieques, Puerto Rico

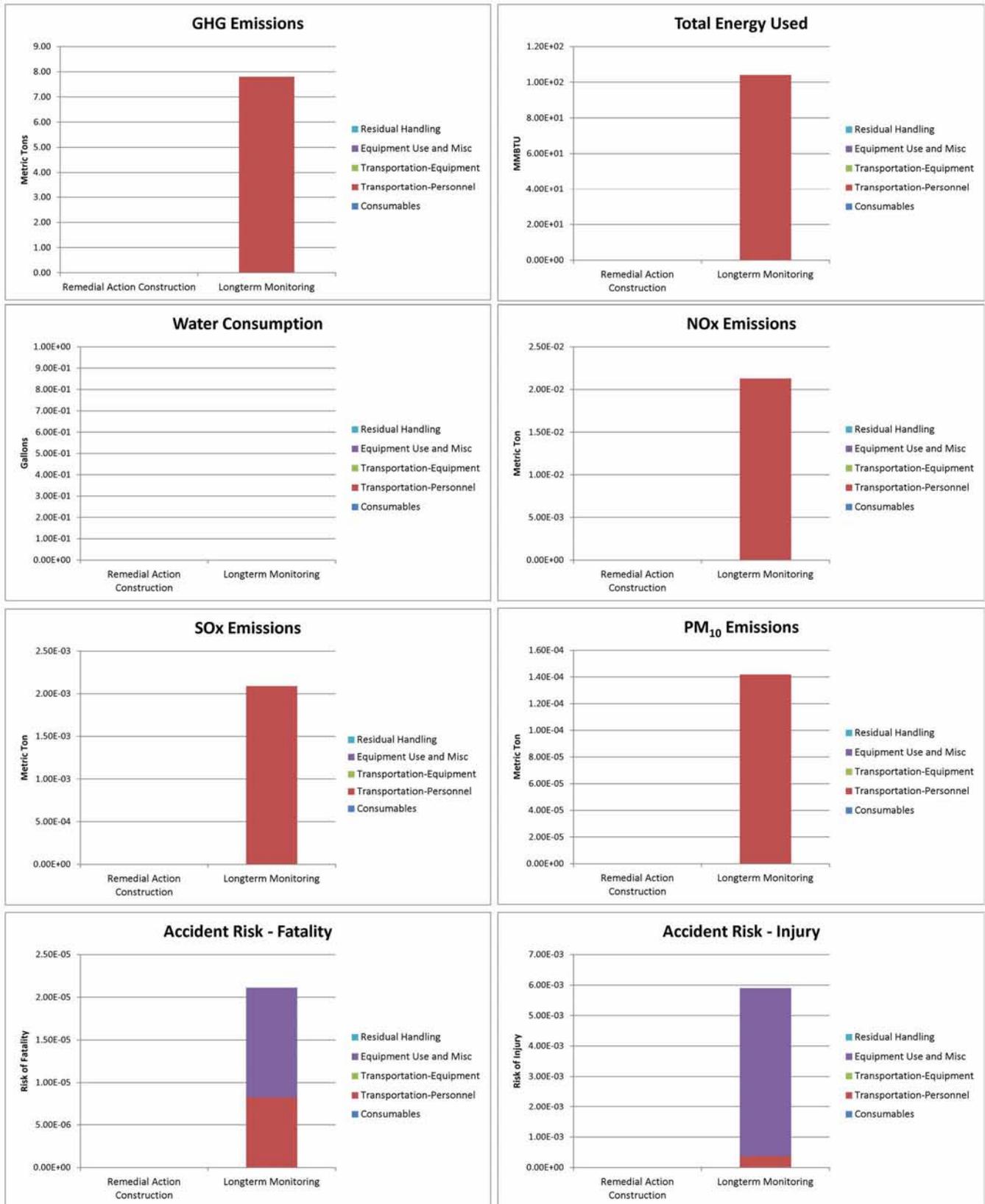


Figure B-2
 Alternative 1 - No Action Results
 UXO 1, Eastern Conservation Area
 Feasibility Study Report
 Former Vieques Naval Training Reserve
 Vieques, Puerto Rico

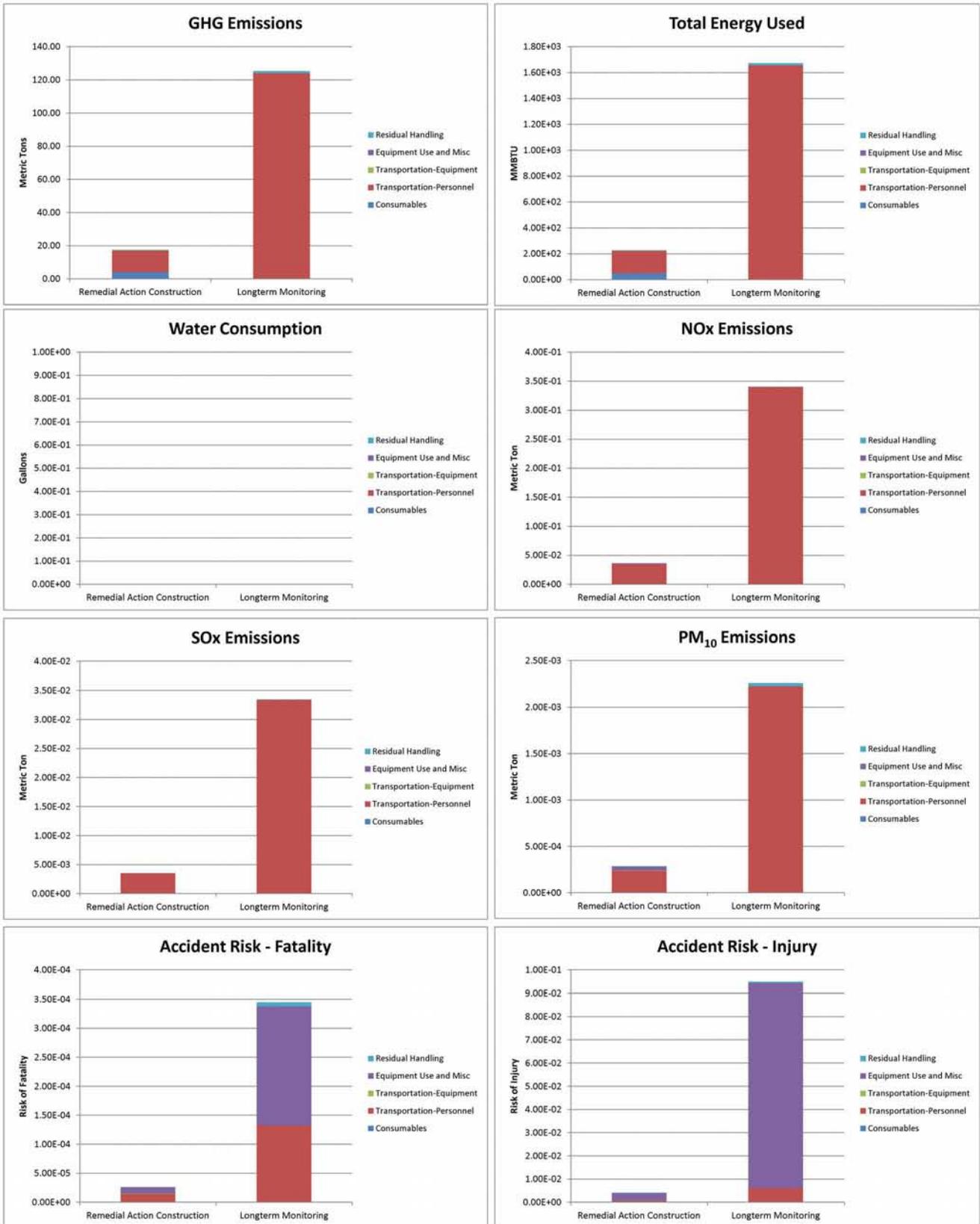


Figure B-3
 Alternative 2 - Limited MEC Removal and LUCs Results
 UXO 1, Eastern Conservation Area
 Feasibility Study Report
 Former Vieques Naval Training Reserve
 Vieques, Puerto Rico

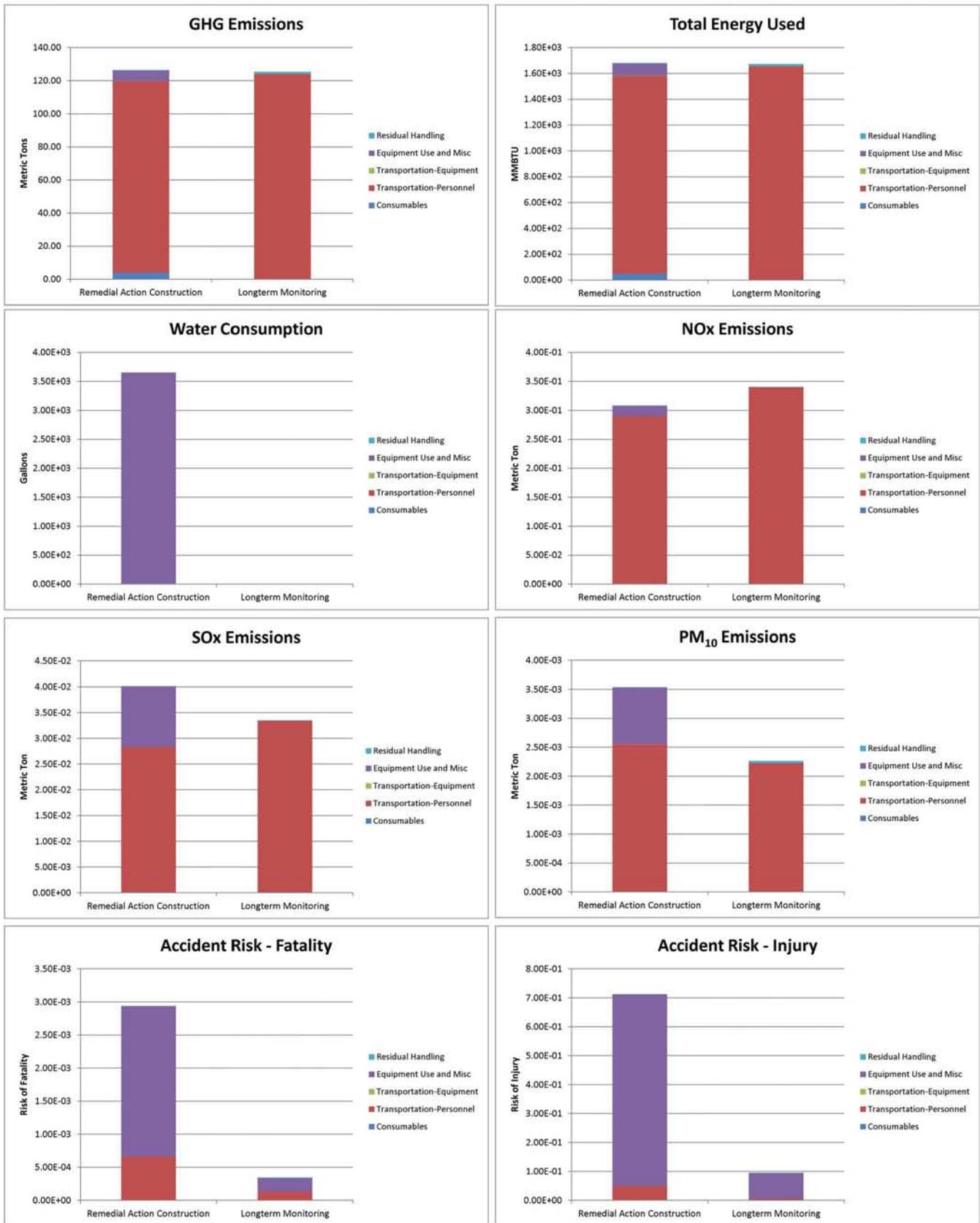


Figure B-4
 Alternative 3 - Subsurface MEC Removal and LUCs Results
 UXO 1, Eastern Conservation Area
 Feasibility Study Report
 Former Vieques Naval Training Reserve
 Vieques, Puerto Rico

Appendix C
Cost Estimates

Alternative 1 - No Action

(Accuracy Range: +50% / -30%)

Site: UXO 1, Eastern Conservation Area
 Location: Former VNTR, Vieques, Puerto Rico
 Phase: Feasibility Study (FS)

Base Year: 2012
 Date: August 2012

Alternative Description:

- Site remaining in its current condition (MEC surface removal completed for the 125-acre area; and surface and subsurface clearance completed along the beach and access roads);
- No additional surface and subsurface MEC removal;
- Access to the site partially restricted by natural features (i.e., coral barriers and steep cliffs), passage through a Congressionally-designated Wilderness Area; and chain-link fences, and locked gated roads with signage;
- No long-term monitoring (LTM) program (i.e., partial restrictions would not be enforced and monitored);
- 5-year reviews for 30 years.

Description	Quantity	Unit	\$/Unit	Total Cost	Notes
(1) CONSTRUCTION COST	1	LS	\$0	\$0	NA
(2) DESIGN & CM & PM	1	LS	\$0	\$0	NA
(3) PERIODIC COST - LTM	1	LS	\$0	\$0	NA
(4) PERIODIC COST - 5-YR REVIEW					
4.1 Community Involvement and Notification	16	HR	\$125	\$2,000	
4.2 Document Review and Analysis	30	HR	\$125	\$3,750	
4.3 Interviews	20	HR	\$125	\$2,500	
4.4 Site Inspection	60	HR	\$125	\$7,500	2-person, 2-day; including travel
4.5 Five-Year-Review Report Preparation	160	HR	\$125	\$20,000	
4.6 Airfare and Lodging	1	LS	\$3,175	\$3,175	2-person 2 nights
Subtotal				<u>\$38,925</u>	
Contingency	20%		\$38,925	\$7,785	
Project Management	10%		\$46,710	\$4,671	10% (EPA July 2000 Guidance)
SINGLE EVENT COST - 5-YR REVIEW				<u>\$52,000</u>	

Year	Periodic Cost	Discount Factor	NPV Cost	Based on OMB discount rate
0	\$ -	1.00000	\$ -	
5	\$ 52,000	0.90130	\$ 46,868	5-year review report
10	\$ 52,000	0.75870	\$ 39,452	5-year review report
15	\$ 52,000	0.63259	\$ 32,895	5-year review report
20	\$ 52,000	0.50257	\$ 26,133	5-year review report
25	\$ 52,000	0.41305	\$ 21,479	5-year review report
30	\$ 52,000	0.32665	\$ 16,986	5-year review report

Total Periodic Cost - 5-YR REVIEW (NPV)	\$ 184,000
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(5) TOTAL PROJECT COST (NPV in 2012 \$)	\$184,000
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Note:

This estimate has been developed and provided as an order of magnitude budgetary estimate and as such is suitable for the purpose of budget development and/or planning only. This estimate is offered as an opinion of cost to perform the work and is not an offer to contract for construction services, procure, and/or provide such services. The final costs of the project will depend on actual labor and material costs, competitive market conditions, actual site conditions, final project scope, implementation schedule, and other variables.

Alternative 2 - Land Use Controls (LUCs) and Limited MEC Removal

(Accuracy Range: +50% / -30%)

Site: UXO 1, Eastern Conservation Area
 Location: Former VNTR, Vieques, Puerto Rico
 Phase: Feasibility Study (FS)
 Alternative Description:

Base Year: 2012
 Date: August 2012

- No additional surface MEC removal;
- Limited additional subsurface MEC removal to clear access pathways, clear trees, and manage land as needed
- Implement ICs that restrict access and intrusive work and future site development
- Implement engineering controls via LUC plan (fencing and sign installation);
- Implement a long-term monitoring (LTM) program (i.e., site inspections for trespassing, erosion, MEC, and fencing/signage) remove/dispose of any MEC exposed at the ground surface
- 5-year reviews for 30 years.

Description	Quantity	Unit	\$/Unit	Total Cost	Notes
(1) LIMITED MEC REMOVAL					
1.1 Digital Geophysical Mapping	2	Acres	\$4,000	\$8,000	Assuming 3,500 LF x 25 ft
1.2 Vegetation Clearance with Mechanical Means	2	Acres	\$10,789	\$21,578	Estimate per similar work (2011-CTC)
1.3 MEC Subsurface Removal to 2 ft bgs (up to 100 items / acre)	200	Anomaly	\$339	\$67,800	Estimate per similar work (2011-CTC);
1.4 RRD Scrap Management	2	ton	\$509	\$1,018	1 ton/acre; Estimate per similar work (2011-CTC)
1.5 MD Scrap Management	2	ton	\$1,292	\$2,584	1 ton/acre; Estimate per similar work (2011-CTC)
1.6 Erosion Control (Silt Fencing/Hay Bales)	7050	LF	\$5	\$35,250	Assuming downgradient silt fencing during construction; Engineer's estimate
SUBTOTAL 1 - CONSTRUCTION COST				\$136,230	
(2) Demilitarization of MEC Items					
2.1 Demolition/Explosive Venting	2	Event	\$6,773	\$13,546	Assuming 2 events to support miscellaneous activities; Estimate per similar work (EE-CA, 2008)
		Escalation Factor	116%		2008 cost escalated to 2012 cost by interest rate of 3.8%
SUBTOTAL 2 - CONSTRUCTION COST				\$15,725	
(3) Expenses and Consumables					
3.1 Travel by air	6	Trip	\$2,000	\$12,000	1 site manager, 1 UXO Techs, and 1 admin support professional for oversight. UXO team covered in Tasks 1 & 2
3.2 Lodging Per Diem (per person)	12	Days	\$175	\$2,100	1 site manager, 1 UXO Techs, and 1 admin support professional for oversight. UXO team covered in Tasks 1 & 2
3.3 Meal Per Diem per day	12	Days	\$95	\$1,140	1 site manager, 1 UXO Techs, and 1 admin support professional for oversight. UXO team covered in Tasks 1 & 2
3.4 Car Rental and Fuel	2	Week	\$500	\$1,000	2 vehicles
3.5 MEC Locator Schondstet/All Metals Detectors	2	EA	\$1,100	\$2,200	1 per UXO tech
3.6 GPS	2	Week	\$80	\$160	1 per UXO tech
3.7 Daily Consumables	12	Days	\$15	\$180	Estimate per similar work (EE-CA, 2008)
3.8 Health and Safety Consumables	12	Days	\$20	\$240	Estimate per similar work (EE-CA, 2008)
SUBTOTAL 3 - CONSTRUCTION COST				\$19,020	

Alternative 2 - Land Use Controls (LUCs) and Limited MEC Removal

(Accuracy Range: +50% / -30%)

Site: UXO 1, Eastern Conservation Area
 Location: Former VNTR, Vieques, Puerto Rico
 Phase: Feasibility Study (FS)
 Alternative Description:

Base Year: 2012
 Date: August 2012

- No additional surface MEC removal;
- Limited additional subsurface MEC removal to clear access pathways, clear trees, and manage land as needed
- Implement ICs that restrict access and intrusive work and future site development
- Implement engineering controls via LUC plan (fencing and sign installation);
- Implement a long-term monitoring (LTM) program (i.e., site inspections for trespassing, erosion, MEC, and fencing/signage) remove/dispose of any MEC exposed at the ground surface
- 5-year reviews for 30 years.

Description	Quantity	Unit	\$/Unit	Total Cost	Notes
(4) ESTABLISHING ICs and LUCs					
2.1 Deed and Bound Survey	1	LS	\$30,000	\$30,000	Estimate
2.2 Prepare Deed Recordation Document	1	LS	\$15,000	\$15,000	Estimate
2.3 Fence/Sign Buffer Vegetation Clearance	1	Acres	\$10,789	\$10,789	Assuming 15-foot wide buffer for access to fence installation & sign installation; Estimate per similar work (2011-CTC)
2.4 MEC Avoidance Support	5	day	\$1,400	\$7,000	Estimate per similar work (2011-CTC)
2.5 Installation of Additional Fence	2610	LF	\$11.76	\$30,698	3-strand, barbless wire fence; adjusted (4%) 2011 RSMeans 32 31 26.20 0210 & 32 31 13.30 6595; 30% for Vieques
2.6 Signage for Restricting Access and Intrusive Activities	53	EA	\$200	\$10,600	Estimate per similar work. 1 sign per 50 feet.
2.7 Re-vegetation	1	Acres	\$6,528	\$6,528	Assuming natural revegetation; RS Mean 2003 escalated by interest rate of 3.8% with 30% increase for Vieques
SUBTOTAL 4 - CONSTRUCTION COST				\$110,615	
SUBTOTALS 1 + 2 + 3 + 4 CONSTRUCTION COST				\$281,590	
CONTINGENCY (20%)				\$56,318	
TOTAL CONSTRUCTION COST				\$337,908	
(3) DESIGN & CM & PM					
Project Management	8%		\$337,908	\$27,033	EPA July 2000 guidance page 5-13
Remedial Design	6%		\$337,908	\$20,275	NAVFAC Policy (6% maximum)
Construction Management	10%		\$337,908	\$33,791	EPA July 2000 guidance page 5-13
General&Administration (G&A)	9.2%		\$337,908	\$31,088	RSMeans 5% to 15%
Pollution Liability Insurance	2%		\$337,908	\$6,758	market price
Payment & Performance Bond	1.75%		\$337,908	\$5,913	market price
Fee	8%		\$337,908	\$27,033	
Tax	6%		\$337,908	\$20,275	Puerto Rico tax
TOTAL - Design & CM & PM				\$173,000	
TOTAL Capital Cost				\$511,000	

Alternative 2 - Land Use Controls (LUCs) and Limited MEC Removal

(Accuracy Range: +50% / -30%)

Site: UXO 1, Eastern Conservation Area
 Location: Former VNTR, Vieques, Puerto Rico
 Phase: Feasibility Study (FS)
 Alternative Description:

Base Year: 2012
 Date: August 2012

- No additional surface MEC removal;
- Limited additional subsurface MEC removal to clear access pathways, clear trees, and manage land as needed
- Implement ICs that restrict access and intrusive work and future site development
- Implement engineering controls via LUC plan (fencing and sign installation);
- Implement a long-term monitoring (LTM) program (i.e., site inspections for trespassing, erosion, MEC, and fencing/signage) remove/dispose of any MEC exposed at the ground surface
- 5-year reviews for 30 years.

Description	Quantity	Unit	\$/Unit	Total Cost	Notes
(4) PERIODIC COST - LTM					
					annual site inspection + post-storm inspection
3.1 Reporting	80	HR	\$100	\$8,000	
3.2 Travel by air	3	Each	\$2,000	\$6,000	3 persons per team; 1 team; includes 2 UXO techs;
3.3 Site inspection	180	HR	\$125	\$22,500	3-persons, including 2 UXO Techs, 2-day; including travel
3.4 Lodging Per Diem (per person)	24	Days	\$350	\$8,400	3 persons per team; 1 team; includes 2 UXO Techs;
3.5 Meal Per Diem per day	24	Days	\$190	\$4,560	3 persons per team; 1 team; includes 2 UXO Techs;
3.6 Car Rental and Fuel	3	Week	\$500	\$1,500	3 persons
3.7 Removal of MEC at the surface	1	LS	\$2,400	\$2,400	equivalent of 0.1 acre of clearance per year
3.8 MD Scrap Management	0.5	ton	\$1,292	\$646	
3.7 General&Administration (G&A)	1	LS	\$4,969	\$4,969	RSMMeans 5% to 15%
Subtotal				\$58,975	
CONTINGENCY	20%		\$58,975	\$11,795	
Project Management	10%		\$70,769	\$7,077	
Annual LTM Cost				\$78,000	
TOTAL LTM Cost (NPV)			3.80%	\$1,383,000	Based on discount rate of 3.8% for 30 years

(5) PERIODIC COST - 5-YR REVIEW					
4.1 Community Involvement and Notification	16	HR	\$125	\$2,000	
4.2 Document Review and Analysis	30	HR	\$125	\$3,750	
4.3 Interviews	20	HR	\$125	\$2,500	
4.4 Site Inspection	60	HR	\$125	\$7,500	2-person, 2-day; including travel
4.5 Five-Year-Review Report Preparation	160	HR	\$125	\$20,000	
4.6 Airfare and Lodging	1	LS	\$3,175	\$3,175	2-person 2 nights
Subtotal				\$38,925	
Contingency	20%		\$38,925	\$7,785	
Project Management	10%		\$46,710	\$4,671	10% (EPA July 2000 Guidance)
SINGLE EVENT COST - 5-YR REVIEW				\$52,000	

Year	Periodic Cost	Discount Factor	NPV Cost	Notes
0	\$ -	1.00000	\$ -	
5	\$ 52,000	0.90130	\$ 46,868	5-year review report
10	\$ 52,000	0.75870	\$ 39,452	5-year review report
15	\$ 52,000	0.63259	\$ 32,895	5-year review report
20	\$ 52,000	0.50257	\$ 26,133	5-year review report
25	\$ 52,000	0.41305	\$ 21,479	5-year review report
30	\$ 52,000	0.32665	\$ 16,986	5-year review report

Total Periodic Cost - 5-Yr Review (NPV) \$ 184,000

(6) TOTAL PROJECT COST (NPV in 2012 \$) \$2,078,000

Note:

This estimate has been developed and provided as an order of magnitude budgetary estimate and as such is suitable for the purpose of budget development and/or planning only. This estimate is offered as an opinion of cost to perform the work and is not an offer to contract for construction services, procure, and/or provide such services. The final costs of the project will depend on actual labor and material costs, competitive market conditions, actual site conditions, final project scope, implementation schedule, and other variables.

**Alternative 3 - Subsurface Munitions and Explosives of Concern (MEC) Removal
Land Use Controls (LUCs)
(Accuracy Range: +50% / -30%)**

Site: UXO 1, Eastern Conservation Area
Location: Former VNTR, Vieques, Puerto Rico
Phase: Feasibility Study (FS)
Alternative Description:

Base Year: 2012
Date: August 2012

- Subsurface clearance of the remaining accessible terrestrial area (excluding the previously cleared beach and access road areas and areas with exposed bedrock);
- Subsurface clearance of 9-acre lagoon to 2 ft bgs after dewatering.
- Implement ICs that restrict access and intrusive work and future site development
- Implement engineering controls via LUC plan (fencing and sign installation).
- Implement a long-term monitoring (LTM) program (i.e., site inspections for trespassing, erosion, MEC, and fencing/signage) remove/dispose of any MEC exposed at the ground surface
- 5-year reviews for 30 years.

Description	Quantity	Unit	\$/Unit	Total Cost	Notes
(1) Mobilization/Demobilization and Site Setup					
1.1 Work Plans	1	EA	\$50,000	\$50,000	Estimate per similar work (EE-CA, 2008)
1.2 Mobilization	1	EA	\$65,000	\$65,000	Estimate per similar work (EE-CA, 2008)
1.3 Demobilization	1	EA	\$45,000	\$45,000	Estimate per similar work (EE-CA, 2008)
1.4 Road Repair	1	LS	\$7,500	\$7,500	Estimate per similar work (EE-CA, 2008)
1.5 Establish Grids	1	LS	\$20,000	\$20,000	Estimate per similar work (EE-CA, 2008)
1.6 Digital Geophysical Mapping	104	Acres	\$4,000	\$416,000	For non-lagoon area not addressed during NTCRA; Estimate per similar work (EE-CA, 2008). Includes even bedrock areas due to NTCRA road experience.
				\$603,500	
Escalation Factor		117%	\$603,500		2008 cost escalated to 2012 cost by interest rate of 4%
Subtotal 1				\$706,010	
(2) MEC Clearance					
Terrestrial Area					
2.1 Vegetation Clearance with Mechanical Means	59	Acres	\$10,789	\$636,551	Estimate per similar work (2011-CTC)
2.2 MEC Subsurface Removal to 2 ft bgs (up to 100 items / acre)	5,900	Anomaly	\$339	\$2,000,100	Estimate per similar work (2011-CTC);
2.3 RRD Scrap Management	59	ton	\$509	\$30,031	1 ton/acre; Estimate per similar work (2011-CTC)
2.4 MD Scrap Management	59	ton	\$1,292	\$76,228	1 ton/acre; Estimate per similar work (2011-CTC)
2.5 Erosion Control (Silt Fencing/Hay Bales)	30000	LF	\$5	\$150,000	Assuming downgradient silt fencing during construction; Engineer's estimate
2.6 Re-vegetation	10	Acres	\$6,528	\$65,279	Assuming natural re-vegetation; RS Mean 2003 escalated by interest rate of 3.8% with 30% increase for Vieques
Subtotal - Terrestrial Area				\$2,958,189	

Alternative 3 - Subsurface Munitions and Explosives of Concern (MEC) Removal
Land Use Controls (LUCs)
(Accuracy Range: +50% / -30%)

Site: UXO 1, Eastern Conservation Area
 Location: Former VNTR, Vieques, Puerto Rico
 Phase: Feasibility Study (FS)
 Alternative Description:

Base Year: 2012
 Date: August 2012

- Subsurface clearance of the remaining accessible terrestrial area (excluding the previously cleared beach and access road areas and areas with exposed bedrock);
- Subsurface clearance of 9-acre lagoon to 2 ft bgs after dewatering.
- Implement ICs that restrict access and intrusive work and future site development
- Implement engineering controls via LUC plan (fencing and sign installation).
- Implement a long-term monitoring (LTM) program (i.e., site inspections for trespassing, erosion, MEC, and fencing/signage) remove/dispose of any MEC exposed at the ground surface
- 5-year reviews for 30 years.

Description	Quantity	Unit	\$/Unit	Total Cost	Notes
Lagoon					
2.8 Mob/Demob for Dewatering	1	LS	\$50,000	\$50,000	Estimate
2.9 Water Treatment During Construction (Dewatering and Stormwater)	14,662,296	GAL	\$0.006	\$87,974	9 acres, 2 ft depth; 6" direct precipitation plus rain/storm/tidal with a safety factor of 2; Settling Tanks and GAC for treatment prior to discharge
2.10 Sump Pumps and Control - 500 gpm	20	days	\$1,364	\$27,777	total flow 500 gpm; two 20-hp 300-gpm pumps; One pump on-line and operated 24/7 plus 80-ft suction and 600-ft discharge hose; RSM means adjusted rate: \$1,364/dy 7 days per week
2.11 Stormwater Prevention (Sumps, Pumps, Pipe, and Control)	1	LS	\$50,000	\$50,000	Estimate
2.12 Digital Geophysical Mapping	9	Acres	\$4,000	\$36,000	For lagoon area subsurface clearance area; Estimate per similar work (EE-CA, 2008)
2.13 MEC Subsurface Removal to 2 ft bgs (up to 100 items / acre)	900	Anomaly	\$339	\$305,100	Lagoon; assume 30 anomalies per day; Estimate per similar work (2011-CTC)
2.14 RRD Scrap Management	9	ton	\$509	\$4,581	Estimate per similar work (2011-CTC)
2.15 MD Scrap Management	9	ton	\$1,292	\$11,628	Estimate per similar work (2011-CTC)
Subtotal- Lagoon				\$573,060	
Subtotal 2				\$3,531,248	
(3) Demilitarization of MEC Items					
3.1 Demolition/Explosive Venting	26	Event	\$6,773	\$176,098	Assuming 1 event every 2 weeks; Estimate per similar work (EE-CA, 2008)
Escalation Factor			116%		2008 cost escalated to 2012 cost by interest rate of 3.8%
Subtotal 3				\$204,430	
(4) Expenses and Consumables					
4.1 Travel by air	52	Trip	\$2,000	\$104,000	1 site manager, 2 UXO Techs, and 1 admin support professional; UXO teams covered in Tasks 1 - 3
4.2 Lodging Per Diem (per person)	1560	Days	\$175	\$273,000	1 site manager, 2 UXO Techs, and 1 admin support professional; UXO teams covered in Tasks 1 - 3
4.3 Meal Per Diem per day	1560	Days	\$95	\$148,200	1 site manager, 2 UXO Techs, and 1 admin support professional; UXO teams covered in Tasks 1 - 3
4.4 Car Rental and Fuel	104	Week	\$500	\$52,000	2 vehicles
4.5 MEC Locator Schondstet/All Metals Detectors	2	EA	\$1,100	\$2,200	1 per UXO tech
4.6 GPS	104	Week	\$80	\$8,320	1 per UXO tech
4.7 Daily Consumables	1560	Days	\$15	\$23,400	Estimate per similar work (EE-CA, 2008)
4.8 Health and Safety Consumables	1560	Days	\$20	\$31,200	Estimate per similar work (EE-CA, 2008)
Subtotal 4				\$642,320	

**Alternative 3 - Subsurface Munitions and Explosives of Concern (MEC) Removal
Land Use Controls (LUCs)
(Accuracy Range: +50% / -30%)**

Site: UXO 1, Eastern Conservation Area
Location: Former VNTR, Vieques, Puerto Rico
Phase: Feasibility Study (FS)
Alternative Description:

Base Year: 2012
Date: August 2012

- Subsurface clearance of the remaining accessible terrestrial area (excluding the previously cleared beach and access road areas and areas with exposed bedrock);
- Subsurface clearance of 9-acre lagoon to 2 ft bgs after dewatering.
- Implement ICs that restrict access and intrusive work and future site development
- Implement engineering controls via LUC plan (fencing and sign installation).
- Implement a long-term monitoring (LTM) program (i.e., site inspections for trespassing, erosion, MEC, and fencing/signage) remove/dispose of any MEC exposed at the ground surface
- 5-year reviews for 30 years.

Description	Quantity	Unit	\$/Unit	Total Cost	Notes
(5) Establishing IC and LUC					
5.1 Deed and Bound survey	1	LS	\$30,000	\$30,000	Estimate
5.2 Prepare Deed Recordation Document	1	LS	\$15,000	\$15,000	Estimate
5.3 Fence Buffer Vegetation Clearance with Mechanical Means	1	Acres	\$10,789	\$10,789	Assuming 15-foot wide buffer for access to fence installation; Estimate per similar work (EE-CA, 2008)
5.4 Vegetation Clearance MEC Avoidance Support	5	days	\$1,400	\$7,000	Estimate per similar work (EE-CA, 2008)
5.5 Installation of Additional Fence	2610	LF	\$11.76	\$30,698	3-strand, barbless wire fence; adjusted (4%) 2011 RSMMeans 32 31 26.20 0210 & 32 31 13.30 6595; 30% for Vieques
5.6 Signage for Restricting Access and Intrusive Activities	53	EA	\$200	\$10,600	Estimate per similar work. 1 sign per 50 feet.
Subtotal 5				\$104,087	
Subtotal (1+2+3+4+5)				\$5,189,000	
CONTINGENCY	20%		\$5,189,000	\$1,038,000	EPA July 2000 guidance
SUBTOTAL - CONSTRUCTION COST				\$6,227,000	
(6) DESIGN&CM&PM					
Project Management	5%		\$6,227,000	\$311,350	EPA July 2000 guidance page 5-13
Remedial Design	6%		\$6,227,000	\$373,620	NAVFAC Policy (6% maximum)
Construction Management	6%		\$6,227,000	\$373,620	EPA July 2000 guidance page 5-13
General&Administration (G&A)	9.2%		\$6,227,000	\$572,884	RSMMeans 5% to 15%
Pollution Liability Insurance	2%		\$6,227,000	\$124,540	market price
Payment & Performance Bond	1.25%		\$6,227,000	\$77,838	market price
Fee	8%		\$6,799,884	\$543,991	
Tax	6%		\$6,227,000	\$373,620	Puerto Rico tax
TOTAL - Design &CM&PM				\$2,752,000	
TOTAL Capital Cost				\$8,979,000	
(7) LTM COST					
					annual site inspection + post-storm inspection
7.1 Reporting	80	HR	\$100	\$8,000	
7.2 Travel by air	3	Each	\$2,000	\$6,000	3 persons per team; 1 team; includes 2 UXO techs;
7.3 Site Inspection	180	HR	\$125	\$22,500	3-persons, including 2 UXO Techs, 2-day; including travel
7.4 Lodging Per Diem (per person)	24	Days	\$350	\$8,400	3 persons per team; 1 team; includes 2 UXO Techs;
7.5 Meal Per Diem per day	24	Days	\$190	\$4,560	3 persons per team; 1 team; includes 2 UXO Techs;
7.6 Car Rental and Fuel	3	Week	\$500	\$1,500	3 persons
7.7 Removal of MEC at the surface	1	LS	\$2,400	\$2,400	equivalent of 0.1 acre of clearance per year
7.8 MD Scrap Management	0.5	ton	\$1,292	\$646	
7.9 General&Administration (G&A)	1	LS	\$4,969	\$4,969	RSMMeans 5% to 15%
Subtotal 7				\$58,975	
Contingency	20%		\$58,975	\$11,795	
Project Management	10%		\$70,769	\$7,077	
Annual LTM Cost				\$78,000	
LTM Subtotal Cost (NPV)			3.80%	\$1,383,000	Based on discount rate of 3.8% for 30 years

**Alternative 3 - Subsurface Munitions and Explosives of Concern (MEC) Removal
Land Use Controls (LUCs)
(Accuracy Range: +50% / -30%)**

Site: UXO 1, Eastern Conservation Area
Location: Former VNTR, Vieques, Puerto Rico
Phase: Feasibility Study (FS)
Alternative Description:

Base Year: 2012
Date: August 2012

- Subsurface clearance of the remaining accessible terrestrial area (excluding the previously cleared beach and access road areas and areas with exposed bedrock);
- Subsurface clearance of 9-acre lagoon to 2 ft bgs after dewatering.
- Implement ICs that restrict access and intrusive work and future site development
- Implement engineering controls via LUC plan (fencing and sign installation).
- Implement a long-term monitoring (LTM) program (i.e., site inspections for trespassing, erosion, MEC, and fencing/signage) remove/dispose of any MEC exposed at the ground surface
- 5-year reviews for 30 years.

Description	Quantity	Unit	\$/Unit	Total Cost	Notes
(8) PERIODIC COST					
8.1 Community Involvement and Notification	16	HR	\$125	\$2,000	
8.2 Document Review and Analysis	30	HR	\$125	\$3,750	
8.3 Interviews	20	HR	\$125	\$2,500	
8.4 Site Inspection	60	HR	\$125	\$7,500	2-person, 2-day; including travel
8.5 Five-Year-Review Report Preparation	160	HR	\$125	\$20,000	
8.6 Airfare and Lodging	1	LS	\$3,175	\$3,175	2-person 2 nights
Subtotal				<u>\$38,925</u>	
Contingency	20%		\$38,925	\$7,785	
Project Management	10%		\$46,710	<u>\$4,671</u>	10% (EPA July 2000 Guidance)
SINGLE EVENT COST - 5-YR REVIEW				<u>\$52,000</u>	

Year	Periodic Cost	Discount Factor	NPV Cost	Based on OMB discount rate
0	\$ -	1.00000	\$ -	
5	\$ 52,000	0.90130	\$ 46,868	5-year review report
10	\$ 52,000	0.75870	\$ 39,452	5-year review report
15	\$ 52,000	0.63259	\$ 32,895	5-year review report
20	\$ 52,000	0.50257	\$ 26,133	5-year review report
25	\$ 52,000	0.41305	\$ 21,479	5-year review report
30	\$ 52,000	0.32665	\$ 16,986	5-year review report

Total Periodic Cost (NPV) \$ 184,000

(9) TOTAL PROJECT COST (NPV in 2012 \$) \$10,546,000

Assumptions:

Average water depth of lagoon is 2 ft

Of UXO 1's 133 acres, 8 are inaccessible, 9 are lagoon, 12 are terrestrial areas addressed during NTCRA and requiring no additional MEC removal, and 104 are terrestrial requiring subsurface MEC removal.

Subsurface clearance of 6 acres/month, and MEC removal of 70 anomalies/day for two 4-person teams (terrestrial area);

Subsurface clearance of 4 acre/month, and MEC removal of 70 anomalies/day for two 4-person teams (lagoon);

Vegetation clearance with mechanical means is required for the terrestrial area;

Total active construction period of 21 months (lagoon dewatering 1 months; MEC clearance 20 months for two 4-person teams).

Note:

This estimate has been developed and provided as an order of magnitude budgetary estimate and as such is suitable for the purpose of budget development and/or planning only. This estimate is offered as an opinion of cost to perform the work and is not an offer to contract for construction services, procure, and/or provide such services. The final costs of the project will depend on actual labor and material costs, competitive market conditions, actual site conditions, final project scope, implementation schedule, and other variables.

Appendix D
Responses to Regulatory Comments on the
Draft FS Report

**Final Responses to
EPA Comments on the
Draft Feasibility Study Report
UXO 1, Eastern Conservation Area (ECA),
Former Vieques Naval Training Range
Vieques, Puerto Rico
March 2012**

Presented below are review comments on the *Draft Feasibility Study Report, UXO 1, Eastern Conservation Area (ECA), Former Vieques Naval Training Range, Vieques, Puerto Rico*, dated March 2012 (FS).

GENERAL COMMENTS

1. The remedial action objectives (RAOs) presented in the FS lack sufficient detail. Section 4.1.2.1 (Development and Screening of Alternatives) of the Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (EPA/540/G-89/004), dated October 1988 (RI/FS Guidance) states that RAOs should specify the contaminants and media of interest, exposure pathways, and preliminary remediation goals that permit a range of treatment and containment alternatives to be developed. For UXO 1, the primary exposure pathway is to MEC. However, the RAOs presented in Section 2.1, Remedial Action Objectives, do not include this information; as such, it is unclear if the general response actions presented Table 2-1, Technology Screening Summary, are appropriate. Revise the FS to provide clearly defined RAOs that specify the contaminants or munitions of interest, anticipated exposure pathways, and preliminary remediation goals that permit a range of treatment and containment alternatives to be developed and that will allow for a focused assessment of achieving the RAOs during each 5-year review.

Navy Response:

It should be noted that no unacceptable human health or ecological risks associated with exposure to chemical contaminants in accordance with current and anticipated land use were identified. The RAO "Minimize uncontrolled human contact with potentially contaminated media that may pose an unacceptable risk" was created simply to account for the medium (i.e., groundwater) and exposure scenarios (i.e., industrial and residential use) not evaluated in the human health risk assessment. It is certainly possible that even if groundwater and the other exposure scenarios were evaluated, the chemical exposure risks would still have been acceptable. However, to provide more clarity in the RAO, it has been changed to:

- *Maintain land use that is consistent with the Memorandum of Agreement between the U.S. Department of the Navy and U.S. Department of Interior Concerning the Transfer of Department of Defense Properties on the Eastern End of Vieques Island (Navy and DOI, 2003).*

Reference added to Section 5 References: Department of Navy and Department of Interior (Navy and DOI, 2003). *Memorandum of Agreement Between The United States Department of the Navy and The United States Department of the Interior Concerning The Transfer of Department of Defense Properties on the Eastern End of Vieques Island to The Department of the Interior*. April 30.

The RAO regarding MEC has been revised to add more detail as requested by the comment. The revised RAO is:

- *Minimize the explosive safety risk associated with MEC by minimizing the potential for uncontrolled human contact with MEC potentially present in site soil and lagoon.*

2. According to Section 1.3.2, Nature and Extent of Contamination, “inorganic constituents were detected in soil, surface water, and sediment; however the concentrations were primarily attributed to background (CH2MHill, 2012). The data collected from the soil across UXO 1 suggest leaching of contaminants to groundwater is not a concern.” Based on review of the RI Report, it is unclear if these conclusions have been substantiated. The following are concerns related to the presentation of data in the RI Report:

- a. It is unclear if variations in soil type were considered when evaluating the RI data against the background data sets. Background samples should have the same basic characteristics as that of the investigation samples. Given that the RI samples were collected from areas of potentially varying soil types (upland areas, lowland areas, beach sands, lagoon fringe) it is unclear if this was the case. The Protection of Groundwater Soil Screening Levels (SSLs) calculations in Appendix H of the RI Report took this into account and serves as documentation of the overall soil variability.

Navy Response:

The background soil samples were collected from the same lithologic unit as present in UXO 1, in accordance with the ECA RI SAP, which was developed through multiple scoping sessions conducted with the regulatory agencies.

- b. Review of Table 2-1, Summary of Samples Collected, of the RI Report indicates that subsurface soil samples were collected from varying depths. The RI Report does not specify at what depths background samples were collected as part of the East Vieques Background Study. As such, it is unclear if any differences in sample depths between that of the investigation and background samples affect background comparisons in the RI Report.

Navy Response:

Please see the response to Comment #2a. Further, note that the East Vieques Background Study includes a detailed description of how the subsurface soil samples are statistically representative of each lithologic zone.

- c. Section 4.2.2, Surface Water and Sediment, of the RI Report discusses concentrations of metals detected in sediment relative to that of background soil concentrations; however, the RI Report does not provide a discussion of sediment characteristics relative to that of soil characteristics to show that they are comparable. As such, it is unclear whether sediment characteristics are comparable to background soil characteristics.

Navy Response:

Please see the response to Comment #2a. Further, note that the evaluation of inorganics in sediment presented in the RI Report used a multiple lines of evidence approach as prescribed in the regulatory-approved ECA RI SAP.

- d. With the exception of chromium, it is unclear what the significance (or lack thereof) is of the arsenic, cobalt, and selenium exceedances of the SSLs in surface and subsurface soil samples (see Section 4.2, Nature and Extent of Environmental Media Contamination of the RI Report).

Navy Response:

Please see the response to Comment #2a. Further, note that although arsenic, cobalt, and selenium were observed at concentrations exceeding a screening criterion, they are not commonly used in munitions and, when considered with other multiple lines of evidence as discussed in the Final RI Report, are likely naturally occurring at UXO 1.

- e. Arsenic was detected in one discrete surface soil sample (3SB02) and four discrete subsurface soil samples (2SB02, 2SB08, 2SB11, 2SB15) at concentrations which exceeded the background concentration, the adjusted Regional Screening Level (RSL) for industrial soil, and the SSL; hexavalent chromium was

detected in two discrete subsurface soil samples (2SB07, 2SB09) at concentrations which exceeded the SSLs (no background concentration was available); and cobalt was detected in one discrete subsurface soil sample (2SB11) at a concentration which exceeded the background concentration and the SSL. It is unclear whether step-out samples are warranted to determine the extent of contamination in the vicinity of these sample locations.

Navy Response:

Please see the response to Comments #2a and #2d. Background concentrations are available for hexavalent chromium, which was detected in one background incremental sample at a concentration similar to that observed in the two discrete soil samples collected at the ECA. The Final RI Report concluded that the inorganic constituents discussed above are likely attributable to background.

- f. The third bullet of Section 4.2.1, Soil, of the RI Report states that “SSLs have shown to be unrealistic predictors of leaching to groundwater at other sites within Vieques (CH2MHill, 2010e). Therefore, hexavalent chromium is not a leaching concern for groundwater.” No data have been presented which support this conclusion.

Navy Response:

Please see the Response to Comment #2a. This sentence was removed from the Final RI Report.

- g. As discussed in the RI Report, one surface soil sample was collected from the former battery disposal area, and four metals were detected at concentrations greater than applicable background concentrations and one or more applicable screening criteria. The size of the battery storage area is not discussed in the RI Report; therefore, it is unclear whether one sample was sufficient to characterize the nature and extent of contamination at this area.

Navy Response:

Please see the Response to Comment #2a. The size of the battery disposal area is included in the Final RI Report. The Navy and regulatory agencies jointly scoped and concurred upon the sampling approach for the battery storage area. Further the Navy and regulatory agencies conducted a site visit in January 2010 to verify the location and number of samples required for the UXO 1 SAP, including the battery disposal area.

Address the above-listed concerns in support of the conclusions presented in the FS that contaminant detections are primarily attributed to background concentrations, and that leaching of contaminants to groundwater is not a concern. This information is also necessary to demonstrate that the nature and extent of contamination has been fully addressed and to meet the objective of the remedial investigation/feasibility study process, which is to gather information sufficient to support an informed risk management decision regarding which remedy appears to be most appropriate for a given site (see Section 1.1, Purpose of the RI/FS, of RI/FS Guidance). It is noted that the current uncertainty associated with the nature and extent of contamination at the site directly impacts the ability to make an informed decision regarding the level of risk presented by the site and the appropriate type(s) of remedial response. Once the pending issues identified are addressed, additional comments on the proposed alternatives may be generated.

Navy Response:

Please see the Response to Comment #2a. The FS is based on the conclusions of the RI, which were approved by the regulatory agencies; hence, the RI Report has been issued as final.

3. Section 2.3, General Response Actions, does not discuss what the general response actions (GRAs) for UXO 1 are specifically. According to Table 2-1, the GRAs for UXO 1 include no action, institutional controls, containment, and removal; however, Table 2-1 is not referenced in Section 2.3 and a description of the GRAs

is not provided in the text. Revise the FS to provide a discussion of the GRAs for UXO 1 and reference Table 2-1 as appropriate.

Navy Response:

The following sentence has been added to the end of the 1st paragraph of Section 2.3:

“The GRAs for UXO 1, no action; institutional controls; containment; removal; and treatment, are presented in **Table 2-1.**”

Note that Table 2-1 has been revised to include a treatment GRA.

4. Review of the summary of the comparative analysis presented in Table 4-3, Comparative Analysis of Remedial Alternatives, indicates that the assigned rankings may be inappropriate in some instances. For example, under “short-term effectiveness”, Alternative 2 was assigned a ranking of 3 (good), while Alternative 3 was assigned a ranking of 1 (poor). According to the FS, Alternative 3 will require approximately two to three years to implement, which is a relatively short timeframe. As such, it does not appear that Alternative 3 warrants a ranking of 1 for this category. Similarly, under “overall protection of human health and the environment”, Alternatives 2 and 3 were both assigned a ranking of 4 (excellent). However, Alternative 3 provides a greater level of protection from uncontrolled exposure to munitions and explosives of concern (MEC) than Alternative 2. As such, it does not appear that Alternative 2 warrants a ranking of 4 for this category. Review the rankings presented in Table 4-3 (and Table ES-2) to ensure that they appropriately reflect the ability of each alternative to meet each criterion.

Navy Response:

The sub-criteria for each of the NCP criterion have been added to Table 4-3 and Table ES-2 to make the basis for the relative rankings of the alternatives more clear. Additionally, to avoid misrepresenting the qualitative nature of the evaluation as quantitative, the numbers in the tables have been replaced by symbols. The overall table was reviewed and changes were made to the Long-term Effectiveness and Permanence of Alternative 1 (reduced), Reduction of Toxicity, Mobility, or Volume through Treatment for Alternative 1 (reduced), Short-term Effectiveness for Alternative 3 (increased), and Implementability for Alternative 3 (increased). Although Alternative 3 has a relatively short timeframe for achieving the RAOs, the potential risk to workers during implementation and the significant environmental impacts prevent the alternative from achieving a “good” score; however, the score has been increased to “satisfactory.” Because the threshold criteria are required to be met in order to select an alternative, the scores for Overall Protection of Human Health and the Environment and Compliance with ARARs have been changed to “not met” or “excellent”; both Alternatives 2 and 3 meet the requirement for protection and are, therefore, scored as “excellent.”

In addition, it is unclear which alternative performs the best overall in each category. The RI/FS Guidance states in Section 6.2.5 (Comparative Analysis of Alternatives) on page 6-14, “[a]n effective way of organizing this section is, under each individual criterion, to discuss the alternative(s) that performs the best overall in that category, with other alternatives discussed in the relative order in which they perform [emphasis added]....the presentation of differences among alternatives can be measured either qualitatively or quantitatively, as appropriate, and should identify substantive differences.” Ensure that the assessment clearly indicates the alternative(s) that performs the best overall in each category.

Navy Response:

The text in Section 4.3 has been revised to discuss the alternatives in order of best to worst. In the draft, it was generally sequenced as worst to best, concluding with the best for each criterion. Please see revised Section 4.3 for the details.

5. Based on review of the FS, it is difficult to determine the extent of MEC that has been removed versus the extent that is proposed for clearance under Alternative 2. Section 3.2, Alternative 2 – Limited MEC Removal and LUCs, indicates that Alternative 2 includes subsurface clearance of access pathways; however, review of Section 1.3.2, Nature and Extent of Contamination, indicates that this has already been conducted. Section 4.3.5, Short-Term Effectiveness, states that Alternative 2 includes only minor clearing to facilitate fence installation. Given these discrepancies and the lack of a clear discussion as to what Alternative 2 includes, it is unclear how Alternative 2 meets the RAOs for UXO 1. Revise the FS to provide a clear discussion as to what Alternative 2 includes, to demonstrate how it meets the RAOs.

Navy Response:

The following changes have been made to clarify Alternative 2:

- Figure 3-1: The following note has been added: “Note: The area of limited MEC removal is not depicted on this figure because the actual limited MEC removal area will be based on future needs by FWS. Activities that may require limited MEC remove include tree planting and clearance of new pathways to access areas for land management activities such as turtle nest monitoring. Therefore, limited MEC removal will be conducted on an as-needed basis.”
 - Section 3.2, 1st paragraph, 2nd sentence: “additional” has been added between “along” and “trails” and “, for which areas will be identified on an as-needed basis” has been added to the end.
 - Section 3.2, 1st bullet: “additional” has been added between “of” and “access pathways.”
 - Appendix C, Alternative 2 description: “Limited additional subsurface MEC removal to clear access pathways, clear trees, and manage land as needed” has been added.
6. According to Figure 3-1, Alternative 2 Layout, two sets of warning signs will be posted: one at the border of the Live Impart Area (LIA) and one at the border to UXO 1. However, according to the third bullet under Section 3.2, Alternative 2 – Limited MEC Removal and LUCs, 53 signs will be installed along the western edge of the LIA and no mention is made of installation of signs along the western edge of UXO 1. Revise the text or figure to resolve this discrepancy. Also, ensure the cost estimates in Appendix C are revised as necessary to reflect any changes in the number of signs, if applicable.

Navy Response:

A fence with signs will be posted along the western edge of the LIA only. Figure 3-1 has been revised to remove the row of signs along the western edge of the ECA.

7. According to Section 3.3, Alternative 3 – Subsurface MEC Removal and LUCs, the lagoon will not need to be dewatered, as MEC clearance will take place during dry periods. However, the cost estimate for Alternative 3 presented in Appendix C contains costs for dewatering of the lagoon. It appears these costs should be removed from the estimate. Revise the cost estimate for Alternative 3 to accurately reflect the work that will be completed.

Navy Response:

The need for dewatering is assumed. The 4th bullet of Section 3.3 has been changed to: “The lagoon would need to be dewatered. Although the lagoon is dry at times, restricting work to only dry periods would likely have significant schedule impacts.” In Table ES-1 and 4-1, “lagoon disturbance” had been changed to “lagoon dewatering.” A surface water discharge ARAR has been added to Table A-6.

8. Section 4.3.4, Reduction of Toxicity, Mobility, and Volume through Treatment, notes that a “significant reduction in volume of MEC occurred at the site during the previous removal actions...” and that Alternative 3 would achieve the greatest reduction in volume. However, it should be noted that the previous removal actions and proposed MEC clearance activities do not constitute treatment. Treatment requires a chemical or biological transformation or an immobilization/stabilization process (e.g., by binding contaminant molecules into a cement matrix). Section 4.3.4 should be revised to indicate that the remedial alternatives for UXO 1 do not include treatment. In addition, revise the alternative rankings in Tables ES-2 and 4-3, Comparative Analysis of Remedial Alternatives, to reflect the fact that the alternatives do not meet the “reduction of toxicity, mobility, or volume through treatment” criterion.

Navy Response:

The Navy maintains that destruction of MEC through detonation is a method of treatment, as it employs a chemical reaction as well as a physical process to destroy the explosives, thereby removing the hazard, and recycles the scrap metal. 40 CFR 400.430 defines the criterion as “The degree to which alternatives employ recycling or treatment that reduces toxicity, mobility, or volume...” In addition, the EPA Handbook on the Management of Munitions Response Actions – Interim Final (EPA 505-B-01-001, May 2005), Section 5.2, identifies Open Detonation as a method of MEC treatment. Within the draft FS, Alternative 1 received a favorable score for this criterion because of the degree of treatment that was conducted during the previous removal actions; however, the score has been revised to reflect that treatment is not part of the alternative being evaluated in this FS. Therefore, the score has been changed to “not met” to reflect that no treatment is planned. Table ES-2, Table 4-3, and Section 4.3.4 reflect this change.

9. The term “MEC (munitions and explosives of concern) avoidance” has been replaced by the term “anomaly avoidance” in the Department of Defense Ammunition and Explosives Safety Standards (DoDM 6055.09-M). Replace all occurrences of the term “MEC avoidance” with “anomaly avoidance.”

Navy Response:

“MEC avoidance” has been replaced by “anomaly avoidance” in both occurrences: Section 3.2, 3rd bullet, and Section 3.3, 1st bullet.

10. It appears that some of the tabular information found in Appendix B, Sustainability Analysis, may be inconsistent. Table B-4, Relative Impact of Alternatives, displays results in the “Alternative 1-No Action” row that differ from that found in the “Total” row of Table B-5, Alternative 1-No Action Results. However, the corresponding tables (B-6 and B-7) that report the totals for Alternatives 2 and 3 are consistent with the respective rows for Alternatives 2 and 3 found in Table B-4. Review the cited tables and correct them as necessary. If there is a reason for the differing results, provide the basis thereof.

Navy Response:

The discrepancy between Tables B-4 and B-5 is a rounding discrepancy. Tables B-4 and B-5 have been updated with consistent rounding. Note, because the Sustainability Analysis has been revised to address other comments, most numbers are somewhat different between the draft and draft final FS.

11. As of this date, the EPA has not been provided final reports of the removal actions taken on UXO 1. These final reports should be received and accepted prior to the approval of the final version of this Feasibility Study. Provide the EPA with the final versions of the removal actions as soon as can be reasonably accomplished.

Navy Response:

The Status Report for the NTCRA of UXO 1 was provided to EPA on 8/3/12.

12. There appears to be minor issues concerning the size and composition of UXO 1 (Eastern Conservation Area) that are presented in the FS. The Executive Summary lists the size as “approximately 133 acres.” Section 1.2.2, UXO 1, states that the area is “133 acres.” Section 1.3.2 states that, “Surface removal of MEC, munitions debris (MD), range-related debris (RRD), and cultural debris was conducted across approximately 125 acres of UXO 1 during the TCRA; the remaining area of approximately 8 acres could not be accessed due to physical features (e.g., cliffs) (Figure 1-5). In addition, approximately 12 acres of sandy beaches and roads within the TCRA area were also subject to subsurface removal of MEC, MD, RRD, and cultural debris during the NTCRA (Figure 1-5).” However, Section 3.3, Alternative 3 – Subsurface MEC Removal and LUCs, states that, “Vegetation clearance with MEC avoidance support would be required for the entire accessible portion of the terrestrial area [104 acres, excludes the 12-acre area previously cleared during the NTCRA (Figure 1-5) and the 9-acre lagoon].” Also, Section 4.3.5, Short Term Effectiveness states that, “Potential impacts to the environment are significantly greater with Alternative 3 than with Alternative 2 because of the expansive (approximately 113 acres) temporary land disturbance (e.g., vegetation clearance, portions of which are unique subtropical forest, ground disturbance to remove MEC) included in Alternative 3.” In addition, Appendix D, MEC Hazard Assessment Input and Assumptions, lists the site as 125 acres in size.

While there are likely reasons for each of the numbers provided, it would be helpful if the total size of the site were provided in a tabular form at the first mention thereof, with the components that make up the total listed in the table with their sizes. Provide this information in a table. Also, indicate whether the beaches and roads are considered portions of UXO 1.

Navy Response:

The acreages have been reviewed and were correct in the draft FS. The overall area of UXO 1 is 133 acres. Approximately 8 acres of the site include steep, rocky cliffs that cannot be accessed, resulting in surface clearance of 125 acres. 125 acres is used as the basis for the development of the alternatives since the 8 acres of cliffs cannot be accessed. The 125 acres comprised a 9-acre lagoon, 104 acres of terrestrial area where subsurface clearance has not yet been conducted, and 12 acres where subsurface clearance has been conducted. The Section 4.3.5 reference to 113 acres of land-disturbance included the lagoon because it will be disturbed to remove MEC. Note that the areas of subsurface MEC clearance in the revised FS are somewhat different because they have been adjusted to reflect the estimated area of the exposed bedrock (i.e., no subsurface MEC assumed) where appropriate (see response to PREQB page-specific Comment #5). Further, the area of roads where subsurface clearance was conducted was corrected from 6 acres to 4 acres. The result is that the NTCRA cleared approximately 10 acres of subsurface MEC instead of 12 acres of subsurface MEC; the 104 acres of terrestrial area not yet subsurface cleared has been changed to 106 acres; however, for cost estimating purposes, it is assumed that only 59 acres of the 106 acres will require subsurface clearance to account for the estimated 47 acres of bedrock at the ground surface and correct road acreage; the 113 acres of land disturbance has been changed to 68 and the 104 acres of vegetation clearance has been changed to 59 to reflect the same estimate.

The following table, presented for clarification, summarizes the areas for the draft FS and revised FS. The right hand side of the table has been inserted into the FS Report.

Draft FS (#s represent areas in acres)				Revised FS (#s represent areas in acres)					
	8 (cliffs, inaccessible)	8 (cliffs, inaccessible)	8 (cliffs, inaccessible)		8 (cliffs, inaccessible)	8 (cliffs, inaccessible)	8 (cliffs, inaccessible)	8 (cliffs, inaccessible)	8 (cliffs, inaccessible)
133 (UXO 1)	125 (TCRA surface clearance)	12 (NTCRA subsurface clearance)	12 (NTCRA subsurface clearance)	133 (UXO 1)	125 (area of TCRA surface clearance)	10 (NTCRA subsurface clearance)	10 (NTCRA subsurface clearance)	10 (NTCRA subsurface clearance)	10 (NTCRA subsurface clearance)
			9 (lagoon – no veg clearance required)			9 (lagoon – no veg clearance required)	9 (lagoon – no veg clearance required)	68 (estimatd area of disturbance)	
		113 (remaining for disturbance and subsurface MEC removal)	104 (upland – veg clearance required)			115 (remaining for potential subsurface MEC removal)	106 (upland)		59 (estimated to require subsurface MEC removal & veg clearance)
						47 (estimated bedrock – assumed no subsurface clearance)	47 (estimated bedrock – assumed no disturbance)		
133	133	133	133	133	133	133	133	133	133

SPECIFIC COMMENTS

- Section 1.3.2, Nature and Extent of Contamination, Page 1-3:** This section states that, “The types and distribution of subsurface MEC removed from UXO 1 during the NTCRA are presented in **Table 1-2** and shown in **Figure 1-7**. Figure 1-7 also shows the MD and RRD removed during the NTCRA. The density and distribution of subsurface MEC are generally consistent with those observed for the surface MEC, with the density highest in the vicinity of the LIA. A total of 1,177 discrete anomalies and 6 anomaly polygons were investigated during the NTCRA; a total of 3,539 metallic items were found within those anomalies. A total of 97 MEC (approximately 3 percent of the total number of metallic items identified) were found from 91 of the anomalies (discrete and polygon) identified by digital geophysical mapping (DGM). Due to the presence of bedrock near the ground surface, a majority of the MEC (78 in total) were found within the first 18 inches of excavation. A total of 792 MD were recovered from 333 anomaly locations, and 2,650 RRD were recovered from 1,076 anomaly locations. The distribution and depth intervals were consistent with the MEC identified.”

This section does not indicate the number of anomalies that were investigated and remained unresolved because the investigation was abandoned due to the maximum intrusive depth being reached without resolution. It also does not provide the anomalies that were abandoned prior to resolution due to other factors (e.g., water intrusion, etc.). Without this information, an estimate of the potential MEC remaining in the areas intrusively investigated cannot be made. Revise the noted section to provide this information and include it on an appropriate figure in the FS.

Navy Response:

The following text has been added to Section 1.3.2 of the report:

“Over 1180 DGM anomalies were investigated as part of the NTCRA at UXO 1. Of these, a total of 156 anomalies were not recovered due to the following conditions: 1) at 23 anomaly locations, the anomaly was below the prescribed depth of excavation, 2) at 30 anomaly locations, groundwater was encountered before reaching the source of the anomaly and the excavation was terminated, and 3) at 103 locations

where the initial DGM survey identified an anomaly, no anomaly was identified during the reacquisition process. The locations of the anomalies not recovered are presented on **Figure 1-8.**”

2. **Table 1-2, MEC recovered from UXO 1, page 1 of 1:** This table presents the munitions discovered by an “Item Class” instead of providing the items by individual nomenclature. This makes an evaluation of exactly what was recovered impossible (i.e., the type and size bombs, projectiles, mortars, rockets, and guided missiles that were found and disposed). Expand the cited table to provide this information, or provide a complete listing elsewhere in the FS and reference it in the table or in a footnote.

Navy Response:

Table 1-2 provides a summary of the munitions found during the TCRA and NTCRA by item classification. More specific data collected from the MEC removed from the site during both the TCRA and NTCRA are provided in the TCRA Status Report and the UXO 1 NTCRA Status Report. The pertinent information from the status reports has been added to Table 1-2.

3. **Table 4-1, Detailed Evaluation of Remedial Alternatives:** This table indicates that implementation of Alternative 3 would be a “significant technical challenge” due to dewatering of the lagoon. Section 3.3, Alternative 3 – Subsurface MEC Removal and LUCs indicates that lagoon dewatering will not be necessary. Revise Table 4-1 to reflect the fact that dewatering will not be necessary.

Navy Response:

Please see the response to General Comment 7.

4. **Appendix C, Cost Estimates, Alternative 2 – Land Use Controls (LUCs) and Limited MEC Removal:** According to Section 3.2, Alternative 2 – Limited MEC Removal and LUCs, periodic inspections will be conducted as part of the long term monitoring program for Alternative 2 to identify any MEC that has been exposed at the surface due to erosion. It is unclear if a MEC specialist will be required to participate in the periodic site inspections to identify any MEC, and if costs for one should be included in the estimate provided in Appendix C. Revise the cost estimate for Alternative 2 as necessary.

Navy Response:

UXO Technicians are required for the site inspections because limited MEC removal is assumed. The 2-person team has been increased to a 3-person team because 2 UXO Technicians are required to manage MEC. The cost estimate has been updated and the notes column has been revised to clarify the involvement of UXO Technicians.

5. **Appendix C, Cost Estimates, Alternative 2 – Land Use Controls (LUCs) and Limited MEC Removal:** The estimate for this alternative includes costs for limited MEC removal; however, costs for mobilization/demobilization/travel, etc. associated with MEC removal are not included. It is unclear if costs such as these should be added to the estimate. Revise the estimate for Alternative 2 to include costs related to mobilization/demobilization, or provide justification for why such costs will not be incurred.

Navy Response:

Please see the response to Specific Comment #4. The travel costs are included in the team travel.

6. **Appendix C, Cost Estimates, Alternative 2 – Land Use Controls (LUCs) and Limited MEC Removal:** The alternative description at the top of cost estimate states that no additional surface or subsurface MEC removal will take place; however, this is not the case, according to the text of the FS. Revise the description of the alternative in Appendix C to address this discrepancy.

Navy Response:

The 1st bullet in the alternative description has been changed to: “No additional surface MEC removal” and a second bullet has been added that reads: “Limited additional subsurface MEC removal to clear access pathways, clear trees, and manage land as needed.”

Appendix C, Cost Estimates, Alternative 3 – Subsurface Munitions and Explosives of Concern (MEC) Removal and Land Use Controls (LUCs): The cost estimate for this alternative, assuming 133 acres total in the site, is \$14,708,000.00, or \$110,586.46 per acre. Previous experience involving the same type of removal activities at other similar sites, including sites that are also remote and located on islands, has generally been less than \$100,000.00 per acre. Explain why the costs presented exceed this number.

Navy Response:

The cost estimates for all alternatives are explained in Appendix C. The cost per acre (including vegetation clearance, MEC subsurface removal, and scrap management) is based on actual costs for MEC NTCRA activities at Vieques. Please be more specific with what portions of the cost estimate seem out of line.

**Final Responses to
PREQB Technical Review of the
Draft Feasibility Study Report UXO 1 (Eastern Conservation Area),
Former Vieques Naval Training Range, Vieques, Puerto Rico
March 2012**

GENERAL COMMENTS

Page ES-1, Executive Summary: Please clarify the following approach for this feasibility study, “Because the potential for MEC to be present onsite will remain and changes in site use are not planned, other uses (e.g., residential) were not evaluated. Therefore, as a conservative measure, the potential for unacceptable human health risks for exposure to potentially contaminated media is assumed for site uses not evaluated.” This statement conflicts with Section 1.3.4 which states that no unacceptable risks were identified. PREQB agrees that restrictions are needed to ensure that the assumption remains valid that exposure scenarios not evaluated because they are not reasonably likely to occur (i.e., residential). It is unclear, however, that this means that the stakeholders should assume that there is unacceptable risks for exposure scenarios not evaluated. The land transfer documents restrict land uses at this site; therefore, a residential exposure scenario was considered highly implausible and not evaluated in the risk assessments (just as it is considered implausible for a USFWS worker to work at the site 365 days per year). It seems that the Feasibility Study (FS) needs to acknowledge that the land transfer documents establish legal land use restrictions for the site and that the remediation goal will be to establish suitable institutional controls that complement or support the legal restrictions already in place (assuming such controls are needed in addition to the legal restrictions already in-place). Please consider revising the above statement in the Executive Summary and the Remediation Goal presented in Section 2.1 as well as the rest of the report where reference is made to preventing exposures to potentially contaminated media that may pose an unacceptable risk (e.g., Table 2-1 and Sections 3 and 4) to reflect the legal instruments already in-place, what restrictions are needed in addition to those to ensure that the wildlife refuge remains as such for the future, and to reflect the conclusions of the stakeholder-approved risk assessments presented in Section 1.3.4 that there are no unacceptable risks associated for all anticipated land uses and exposures.

Navy Response:

To clarify the intent of the statement in the Executive Summary, the last sentence of the third paragraph has been revised to:

“Because the potential for MEC to be present onsite will remain and changes in site use are not planned. Therefore, it was not necessary to evaluate other land uses (e.g., residential) nor the medium to which exposure will not be permitted (i.e., groundwater). To ensure these other land uses and/or exposures do not occur, land use controls (LUCs) will be necessary at UXO 1.”

In addition, the following sentence has been added to the end of the Human Health Risk Assessment paragraph of Section 1.3.4 to address the conservatively assumed risk mentioned in the Executive Summary: “However, because exposure scenarios evaluated were selected based on the current and future land use (i.e., wildlife refuge), it is unknown whether unacceptable risk would be present for the medium (i.e., groundwater) and/or exposure scenarios that were not evaluated (e.g., residential).”

In addition, the following has been added as the 2nd sentence of the first paragraph of the Executive Summary: “In 2003, a Memorandum of Agreement was signed by the Department of Navy and Department of the Interior to transfer the eastern end of Vieques, including Area UXO 1, to the Department of the Interior and requiring the land to be administered as a wildlife refuge (Navy and DOI, 2003). In the third sentence of the second paragraph of the Executive Summary, “by U.S. Fish and Wildlife Service” has been added after

“managed.” The 2nd Remedial Action Objective, in the Executive Summary and Section 2.1, has been replaced with “Maintain land use that is consistent with the Memorandum of Agreement between the U.S. Department of the Navy and U.S. Department of Interior Concerning the Transfer of Department of Defense Properties on the Eastern End of Vieques Island (Navy and DOI, 2003).” As applicable, other tables and text have been revised to reflect these revisions.

PAGE-SPECIFIC COMMENTS

1. Page 1-3, Section 1.3.2 says that the quantity of subsurface MEC remaining in the ECA cannot be estimated. However, an estimate of remaining MEC was included in the RI. Please include this estimate in the FS.

Navy Response:

The estimate from the RI Report has been added to the FS Report.

2. Page 1-4, Section 1.3.3, Contaminant Fate and Transport:
 - a. The first sentence mentions the potential for MC to be released from MEC, but the second sentence only indicates that transport mechanisms for MC are insignificant. Please also discuss whether the deterioration of remaining MEC and subsequent release of MC is considered insignificant and discuss all the lines of supporting evidence. Note that this section acknowledges the likely presence of subsurface MEC; therefore, a discussion of the potential for MC releases from remaining subsurface MEC and the potential for leaching to groundwater is needed.

Navy Response:

The 2nd to 4th sentences of the paragraph have been replaced with the following: The potential for MEC at UXO 1 to release chemical contaminants to environmental media, from historical detonations and from deterioration of MEC and related munitions scrap, was initially identified as a potential contaminant fate and transport mechanism. However, the infrequent detections and low concentrations of explosives in surface soil and the absence of explosives in subsurface soil and the lagoon surface water and sediment indicate that the mechanism is insignificant (**Section 1.3.2**). The presence of inorganics was primarily attributed to background rather than the historical detonations and deterioration of MEC and related munitions scrap (CH2M HILL, 2012). Therefore, the potential migration of explosives and inorganics from surface or subsurface MEC from wind erosion, surface runoff, and leaching to and migration with groundwater is also insignificant. Further, surface MEC have been removed from all of the accessible areas of UXO 1, and subsurface MEC have been removed along beaches and roads (**Section 1.3.1**).

- b. Please also discuss the infrequent detections of explosives, as appropriate, as another line of evidence that although MC may be released from MEC, the impact at the site is insignificant.

Navy Response:

Please see the response to Comment 2a.

3. Page 1-4, Section 1.3.4, Human Health Risk Assessment:

- a. Please revise the second sentence of the first paragraph to refer to the legal instrument that establishes the basis for why land use changes are not planned (i.e., that this area has been established by Congress as a wildlife refuge) rather than referring to the Sampling and Analysis Plan which then refers to the land transfer establishing the area as part of the wildlife refuge system where public access is restricted.

Navy Response:

The 1st sentence has been replaced with the following and the 2nd sentence has been deleted: The HHRA considered USFWS workers engaged in a variety of wildlife refuge management and law enforcement activities, trespassers, and Coast Guard Workers because the land is designated as a wildlife refuge under the National Wildlife Refuge System Administration Act of 1966 in accordance with the Memorandum of Agreement between the U.S. Navy and U.S. Department of the Interior (Navy and DOI, 2003). Therefore, site use other than as a wildlife refuge is prohibited and other exposure scenarios (e.g., residential) were not evaluated.

- b. Please address groundwater in this section (i.e., document why groundwater exposure was not evaluated).

Navy Response:

The following has been added after the third sentence under the Human Health Risk Assessment subheading: "Groundwater is currently not used, nor will it likely be used in the future because the land is part of the Congressionally-mandated National Wildlife Refuge, and, therefore, was not evaluated."

4. Page 3-2, Section 3.2, Alternative 2 – Limited MEC Removal and LUCs:

- a. Please clarify how many years long term monitoring of the fence is planned.

Navy Response:

The last two sentences of the LTM bullet have been replaced with the following: "For the purposes of the FS, it is assumed that site inspections will be conducted twice annually, once scheduled and once after a major storm event, for a period of 30 years. The actual frequency and duration of LTM will be included in the LTM work plan provided for regulatory review and approval and will be based on such factors as remaining potential presence of MEC, site conditions, climatic conditions, etc."

- b. Tree planting and other land management activities are likely to occur at the site (tree planting was an assumed activity being conducted at the site for the human health risk assessment, for example). Please clarify why MEC clearance for tree planting and other land management activities is not included in Alternative 2.

Navy Response:

The limited MEC removal component of Alternative 2 is not activity-specific, and the possibility of MEC removal during tree planting and land management activities is captured in the following sentence of the first paragraph of Section 3.2: "Alternative 2 also includes limited MEC removal (e.g., removal of any MEC identified during monitoring, subsurface removal of MEC along additional trails to allow USFWS to gain access to turtle nesting habitats), for which areas will be identified on an as-needed basis." The specific example provided in the comment (*subsurface clearance for tree planting and land management*) has been added to the 1st bullet under the alternative.

5. Page 3-3, Section 3.3: Please clarify why vegetative and subsurface MEC clearance is assumed across the entire accessible portions of UXO 1 when there are bedrock-exposed areas and areas where deeper surface soils are not present. Only those areas with deeper surface soil not addressed during the surface clearance should be included for this alternative. This comment affects the cost estimates and green house gas (GHG) estimates as well as the overall impact/ranking of alternative 3.

Navy Response:

For cost estimating purposes, the assumption that vegetative and subsurface MEC clearance will not be required in areas where bedrock is exposed, which is estimated to be an area of 47 acres, has been added. Note that although it is assumed that subsurface clearance will not be conducted over the area with exposed bedrock, a geophysical survey of the exposed bedrock areas is included within the cost estimate based on experience during the non-time critical removal action, during which subsurface munitions-related items were removed from the road in the area with exposed bedrock. The 1st bullet under the Alternative 3 description has been changed to the following: Vegetation clearance with MEC avoidance support would be required for the entire accessible portion of the terrestrial area [estimated as 59 acres, based on 125 acres where surface clearance was able to be performed minus the 10-acre area previously cleared during the NTCRA (note, was 12 acres in the draft FS), the estimated 47 acres with exposed bedrock (Figure 1-5), and the 9-acre lagoon]. The following text has been added to the end of the third bullet: "For cost estimating purposes, it is assumed that 47 acres of the site have exposed surface bedrock and will not require any subsurface MEC removal." Section 4.3, Table 4-2, Table 4-3, Appendix B, and Appendix C have been updated to reflect the changes.

6. Figure 3-1: Please include the fence (denoted in pink per the legend) on the figure.

Navy Response:

The fence is shown on Figure 3-1.

7. Table 4-1:

- a. Please review this table as it contains some spelling errors and one line of text is partially obscured by the end of a cell.

Navy Response:

Table 4-1 has been edited as requested.

- b. Please clarify the relative GHG emissions predicted for Alternatives 2 and 3 as the level of effort associated with the subsurface MEC removal for Alternative 3 is a multi-year proposition requiring 63,000 hours of MEC removal, 168 airline flights and 166 hours of vegetation clearance while Alternative 2 only requires 1,100 hours of MEC removal, 17 airline flights and 4 hours of vegetation removal. It seems the GHG emissions for Alternative 3 would be much higher than for Alternative 2. Please confirm.

Navy Response:

The predicted difference in GHG emissions for Alternatives 2 and 3 is correct as provided due to the fact that both alternatives have 30 years of identical LTM activities, which result in GHG emissions of 87.1 tons for the LTM phase (Draft FS Tables B-6 and B-7). This accounts for the majority of total GHG emissions for Alternative 2 and approximately 1/3 of the GHG emissions for Alternative 3. The predicted GHG emissions during the RAC phase of Alternative 2 (15.9 metric tons) is almost 100 times lower than the RAC phase of Alternative 3 (147.9 metric tons) (Draft FS Tables B-6 and B-7,

respectively). Note the Sustainability Analysis has been updated to reflect changes made due to other comments; therefore, the values in the revised FS do not match those provided in this response.

To help provide clarification for the reader, the following text has been added to the 3rd paragraph of the Results and Conclusions section of Appendix B: “Although the RAC-phase GHG and total energy footprints for Alternative 2 were less than 30 percent of the RAC-phase footprints for Alternative 3, the LTM footprints were identical and accounted for the majority of Alternative 2 and approximately one-half of the total footprints for Alternative 3, causing the overall difference to be within the 30 to 70 percent range.”

- c. This table also makes the first of many mentions of “lagoon dewatering”. This is inconsistent with Section 3.3, Page 3-3, fourth bullet which says, “The lagoon would not need to be dewatered. Work would be scheduled during dry periods.” There are many other mentions of dewatering the lagoon which are in conflict with Section 3.3 (see Appendix B, third bullet on Page B-2; the third bullet on Page B-3; and the cost estimate for Alternative 3 in Appendix C for examples). Please revise the text, tables and calculations in the appendices to be consistent on this issue.

Navy Response:

The need for dewatering is assumed. The 4th bullet of Section 3.3 has been changed to “The lagoon would need to be dewatered. Although the lagoon is dry at times, restricting work to only dry periods would likely have significant schedule impacts.” In Table ES-2 and 4-1, “lagoon disturbance” had been changed to “lagoon dewatering.” A surface water discharge ARAR has been added to Table A-6.

8. Table 4-3:

- a. Please clarify how Alternative 1 complies with ARARs (currently rated as excellent).

Navy Response:

The ARARs row for Alternative 1 in Table 4-1 has been revised to indicate that action-specific ARARs are “Not applicable. No action-specific ARARs” because the alternative has no action other than 5-year reviews. Therefore, Alternative 1 does not have any chemical- or action-specific ARARs. Because the 5-year reviews include site inspections, the location-specific ARARs apply; however, the ARARs can be met as described in Appendix A, Table A-3.

- b. Please review and revise the cost rankings for Alternatives 2 and 3 as discussed during the May 2012 ERP meeting.

Navy Response:

The cost estimates for Alternatives 2 and 3 have been updated as discussed during the May 2012 ERP meeting, primarily to reduce the subsurface MEC removal area assumption to account for the exposed bedrock in Alternative 3. The cost ranking has been eliminated from Table 4-3 and has been replaced with the estimated total present value for each alternative to eliminate subjectivity.

- c. Please clarify why the scores for Alternatives 1 and 2 are very similar even though Alternative 2 provides significantly more protection through the implementation of LUCs and minor subsurface MEC removal on USFWS trails. Because of this it appears that the final scores for these two alternatives are not representative of the benefit of Alternative 2 over Alternative 1. It is possible that the Alternative 1 scores for “overall protection of human health and the environment” and “implementability” should be lowered because there is no additional protection of human health and the environment offered by

Alternative 1 and it is unlikely that stakeholders and regulators will allow implementation of this alternative.

Navy Response:

Please see the response to EPA General Comment #4. Table 4-3 has been updated accordingly.

9. Please clarify why subsurface clearance of MEC along trails to allow USFWS to access turtle nesting areas is not included in the score presented in the table for Alternative 2. Please note that Section 3.2 on Page 3-1 says this alternative includes subsurface removal of MEC for this purpose.

Navy Response:

Table 4-3 does include subsurface removal of MEC in the scoring criterion listed as Long-term effectiveness and permanence and Reduction of toxicity, mobility, or volume through treatment.

10. Appendix B, Sustainability Analysis:

- a. Both Alternatives 2 and 3 have the same “Residual handling” assumption of “1 ton per year” when it should be assumed that Alternative 3 will have significantly more scrap removed associated with the complete subsurface MEC removal.

Navy Response:

The tables in the Sustainability Analysis are divided into Remedial Action Construction and Long-term Monitoring. Alternatives 2 and 3 each have a residual handling assumption of “1 ton per year” for long-term monitoring because they have the same LTM component. However, the residual handling assumption for Remedial Action Construction was different (4 tons for Alternative 2 and 250 tons for Alternative 3). Note the values in the revised FS are different because the Sustainability Analysis has been updated to reflect other changes resulting from review comments.

- b. Please revise the last sentence of the “Uncertainty Assessment” for clarity.

Navy Response:

The beginning of the sentence, prior to “it can be assumed” has been deleted.

11. Appendix C, Cost Estimates: Please clarify why there are “Re-vegetation” costs associated with “Establishing ICs and LUCs” included in Alternative 2 that aren’t included in Alternative 3 even though the ICs and LUCs are the same for both alternatives. Also, as previously mentioned there are also significant costs for dewatering included for Alternative 3; however, the FS states that dewatering will not be conducted.

Navy Response:

The “Re-vegetation” costs associated with “Establishing ICs and LUCs” were included in the Draft FS in error and have been removed. Minimal clearing will be conducted to install the LUCs and the area will be allowed to naturally re-vegetate with both Alternatives 2 and 3. Dewatering is planned to reduce remedy implementation delays and cost increases.

**Final Responses To
US Fish and Wildlife Service Comments Regarding the
Draft Feasibility Study Report, UXO-1 Eastern Conservation Area,
Former Vieques Naval Training Range,
Vieques, Puerto Rico,
March 2012**

Presented below are the US Fish and Wildlife Service (FWS) thoughts and comments on the subject document.

GENERAL COMMENTS

The FWS is in agreement with the results and findings of the feasibility study and the report conclusions. Additionally, the FWS feels that Alternative 2 will most appropriately address the residual explosive safety risk while maintaining the integrity of the habitat.

SPECIFIC COMMENTS

Table ES-1: The description of the Adequacy and Reliability of Controls for Alternative 2 and Alternative 3 are identical. To distinguish between the two, it is suggested that the subsurface munitions and explosives of concern (MEC) removal be mentioned in the description of Alternative 3.

Navy Response:

Comment noted. However, the removal of subsurface MEC is not considered to be a “control” and is addressed in the “Magnitude of residual risks” category, and the controls proposed for Alternatives 2 and 3 are the same. Therefore, no changes are appropriate for the Adequacy and Reliability of Controls description.

Section 1.2.1: It is suggested that the US Coast Guard (CG) navigation aid (the “light post”) should be briefly mentioned here and in Section 1.2.2.

Navy Response:

The 2nd sentence of the 2nd paragraph of Section 1.2.2 has been revised to the following: “Based on the CCP/EIS, roads within UXO 1 will be used to provide USFWS access to natural resource areas, such as the turtle nesting area along Playa Blanca, and for the USCG to access and maintain the navigation “light post” at the eastern end of UXO 1.”

Section 1.2.2: The statement beginning with “Based on the CCP/EIS, roads within UXO-1 will be used...” implies that the FWS will perform maintenance functions on the light post. It is suggested that this section be revised to indicate that the USCG will access the roads in UXO-1 to perform maintenance of the light post.

Navy Response:

The 2nd sentence of the 2nd paragraph of Section 1.2.2 has been revised to the following: “Based on the CCP/EIS, roads within UXO 1 will be used to provide USFWS access to natural resource areas, such as the turtle nesting area along Playa Blanca, and for the USCG to access and maintain the navigation “light post” at the eastern end of UXO 1.”

Table 1-2: As grenades were not observed in UXO-1 and it is suggested that mention of them be deleted from the table.

Navy Response:

The row labeled as “Grenades” has been deleted from Table 1-2.

Section 3: The surficial geology of UXO-1 is composed of lagoon sediment, beach deposits, shallow limestone derived soils and exposed limestone rock. Due to the predominance of shallow soils and exposed limestone throughout UXO-1, many areas of UXO-1 have a very low probability of containing subsurface MEC. As was done for UXO-15, this fact should be discussed when describing remedial alternatives in this section and elsewhere in the document where appropriate (e.g., Table 4-1, technical feasibility of implementing remedial alternatives).

Navy Response:

Please see the responses to PREQB Page-specific Comments #5 and #8b.

Section 3.2: To be consistent with the last bullet, it is suggested that the sentence beginning with “Alternative 2 also includes the potential for vegetative restoration...” be revised to read “Alternative 2 also includes vegetative restoration...”

Navy Response:

The requested revision has been made.

Section 3.2, Bullet 2: Given that UXO-1 is part of the National Wildlife Refuge system and per the Executive Order guiding the land transfer the ECA is to be managed as a wilderness area, it seems unnecessary to include the phrase “uncontrolled construction/land management” in the 4th sentence. It is suggested that this be deleted and the sentence simply state that “LUCs will provide the ability for planned land use...”

Navy Response:

The requested revision has been made.

Section 3.2, Figure 3-1 and Bullet 3: The graphics in Figure 3-1 suggest that signs will be placed along the ECA/LIA border as well as along the proposed fence line at the SIA/LIA border, yet there is no mention of the signs along the LIA/ECA border in the text. This should be clarified.

Navy Response:

The signs along the ECA/LIA border have been removed from Figure 3-1. No changes have been made to the text.

Appendix C: It is understood that the acreage requiring revegetation (5 acres for Alternative 1 and 10 acres for Alternative 2) and the technical approach proposed (natural revegetation) is for cost estimating and comparative purposes only. However, it is likely that approximately 60 acres of dry upland tropical forest, wetland vegetation and coastal vegetation will need to be addressed as part of the post ROD ecological restoration plan. While not scoped out yet, this plan will likely require a baseline plant survey, the establishment of a plant nursery, active revegetation, adaptive management of invasive species, and long term monitoring. The FWS is committed to work with the Navy, EPA and EQB regarding the ecological restoration of UXO-1 and will actively participate in the planning, management and implementation of a restoration plan.

Navy Response:

Comment noted.