Final

Engineering Evaluation/Cost Analysis for a Non-Time Critical Interim Removal Action at SWMU 4

Atlantic Fleet Weapons Training Area—Vieques
Former Naval Ammunition Support Detachment
Vieques, Puerto Rico

Contract Task Order 005

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CH2MHILL

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Executive Summary

This Engineering Evaluation/Cost Analysis (EE/CA) report presents the evaluation of interim removal action alternatives for a non-time critical removal action (NTCRA) to reduce the explosive hazard associated with potential munitions and explosives of concern (MEC) at Solid Waste Management Unit (SWMU 4), located at the former Vieques Naval Ammunition Support Detachment (NASD), Vieques, Puerto Rico. This NTCRA will ultimately support the final remedy selection for the site and will facilitate near-term public access to portions of the site while additional investigations continue.

SWMU 4 was used for the thermal and explosive destruction of retrograde and surplus munitions, fuels, and propellants from 1969 through 1979 and may have periodically been used as far back as the late 1940s. These Open Burn/Open Detonation (OB/OD) activities likely resulted in ejection of MEC and related debris from the OB/OD pits to the surrounding area. Therefore, the NTCRA will reduce the potential explosive hazard associated with the SWMU 4 areas intended for public access by the land owner (United States Department of Interior [DOI]), reduce the potential explosive hazard in areas where land crabbing occurs or is likely to occur, and reduce the potential for unauthorized access to the restricted areas of the site. The following removal action alternatives were considered:

- Alternative 1 - No Action
  - Alternative 1 consists of performing no interim removal action and serves only as a baseline to which to compare the other alternatives; it is not a viable option considered for the site.
- Alternative 2 – Munitions Removal from Planned Public Areas and Other Likely Accessed Areas, Hazard Warning Signs, and Educational Kiosks
  - Alternative 2 addresses the areas that will be open to the public and those that are likely to be accessed for land crabbing. These areas comprise:
    - OB/OD Pits and Planned Observation Tower Area
    - Planned Parking and Picnic Area
    - Lagoon Fringe Area
- Alternative 3 – Munitions Removal from Planned Public Areas, Hazard Warning Signs, Educational Kiosks, and Confirmatory MEC Extent Determination
  - Alternative 3 contains the same elements as Alternative 2 but includes intrusively investigating a 24-acre area of “spokes,” which originate at the boundary of past MEC removal activities near the OB/OD pits and extend to the site boundary. The “spokes” will serve to support future remedial action evaluations and decisions for the site, as they are expected to confirm the extent of munitions items across SWMU 4 and may be used to refine the area addressed by the final remedy for the site.

This EE/CA includes detailed descriptions, evaluations, and comparative analysis of the alternatives listed below. Based on the evaluation process, Alternative 3 – Munitions Removal from Planned Public Areas, Hazard Warning Signs, Educational Kiosks, and Confirmatory MEC Extent Determination is recommended as the removal action alternative. While Alternative 2 is protective, Alternative 3 provides an additional level of explosive hazard reduction and will provide a significant amount of information that can be used to improve the evaluation and ultimate selection of the final remedy for the site.

Since this NTCRA is only an interim removal action for SWMU 4, the full CERCLA process will continue to evaluate the nature and extent of contamination, potential risks to human health and the environment, and develop and evaluate site-wide remedial alternatives to mitigate unacceptable risks and explosive hazards, if present.

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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.

Resumen Ejecutivo

Este informe de Evaluación de Ingeniería/Análisis de Costos (EECA por sus siglas en inglés) presenta la evaluación de las alternativas de remoción interinas para una Acción de Remoción de Tiempo No-Crítico (NTCRA, por sus siglas en inglés) para reducir el riesgo potencial asociado con las municiones y explosivos de preocupación (MEC, por sus siglas en inglés) en la Unidad de Manejo de Desperdicios Sólidos 4 (SWMU 4, por sus siglas en inglés), localizada en el Antiguo Destacamento de Apoyo de Municiones Navales de Municiones (NASD, por sus siglas en inglés) de Vieques, en Vieques Puerto Rico. En última instancia, el NTCRA va a apoyar la selección del remedio final para el sitio y facilitará el acceso a corto plazo del público a porciones del sitio mientras las investigaciones adicionales continúan.

SWMU 4 fue usado para la destrucción térmica y con explosivos de municiones usadas y sobrantes, combustibles y propulsores desde 1969 a 1979 y pudo haber estado en uso periódicamente desde fines de la década de los cuarenta. Las actividades de Quema Abierta/Detonación Abierta (OB/OD, por sus siglas en inglés) probablemente dieron lugar a la expulsión de MEC y residuos relacionados desde los hoyos abiertos donde se llevaron a cabo al área alrededor. Por lo tanto, la NTCRA reducirá las amenazas relacionadas a explosivos en las áreas de SWMU 4 que han sido identificadas para el acceso del público por el propietario de los terrenos (Departamento del Interior de los Estados Unidos, DOI por sus siglas en inglés), reduce la amenaza potencial relacionada a explosivos en áreas donde se capturan jueyes o donde se pudieran capturar , y reduce el potencial de acceso no autorizado a las áreas restringidas del sitio.

Las siguientes alternativas de remoción fueron consideradas:

- Alternativa 1- Ninguna Acción
  - La Alternativa 1 consiste en no realizar ninguna acción de remoción interina y sirve solamente como una base de referencia para comparar las otras alternativas; no es una opción considerada viable para el sitio.
- Alternativa 2- Remoción de Municiones de las Áreas Planificadas para Uso l Público y otras Áreas de Acceso Probable, Letreros de Advertencia de Peligro y Kioscos educativos.
  - La Alternativa 2 atiende las áreas que estarán abiertas al público y aquellas que probablemente sean visitadas para atrapar jueyes. Estas áreas son:
    - Los hoyos de las áreas OB/OD y el Área planificada para la Torre de Observación
    - El Área Planificada para Estacionamiento y Área de “Picnic”
    - Área del Borde de la Laguna
- Alternativa 3 – Remoción de Municiones de las Áreas Planificadas para Uso Público, Letreros de Advertencia de Peligro, Kioscos Educativos y Determinación Confirmatoria de la Extensión de MEC.
  - La Alternativa 3 contiene los mismos elementos que la Alternativa 2 pero incluye una investigación intrusiva de un área de 24 hectáreas de “radios” (“spokes”) que se originan en los bordes donde se realizaron actividades de remoción de MEC en el pasado cerca de los hoyos OB/ OD, y se extiende hasta los bordes del sitio. Los “radios” servirán para apoyar evaluaciones de las medidas correctivas futuras y las decisiones para el sitio, ya que se espera confirmen la extensión de los artículos de municiones a través de SWMU 4 y pudiera usarse para refinar el área que será atendida por la remediación final del sitio.

Este EE/CA incluye descripciones detalladas, evaluaciones y un análisis comparativo de las alternativas que se describen arriba. Basado en el proceso de evaluación, la Alternativa 3 – Remoción de Municiones de las Áreas Planificadas para Uso Público, Letreros de Advertencia de Peligro, Kioscos Educativos y Determinación Confirmatoria de la Extensión de MEC, se recomienda como la alternativa para la acción de remoción. Mientras que la Alternativa 2 provee protección, la Alternativa 3 provee un nivel adicional de reducción de riesgo

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relacionado a explosivos y proporcionará una cantidad significativa de información que puede ser usada para mejorar la evaluación y selección definitiva del remedio final para el sitio.

Puesto que el NTCRA es sólo una acción de remoción interina para SWMU4, el proceso completo de CERCLA continuará para evaluar la naturaleza y extensión de la contaminación, los riesgos potenciales a la salud humana y el ambiente, y para desarrollar y evaluar las alternativas de remediación para todo el sitio para mitigar riesgos inaceptables y peligros explosivos, de estar presentes.

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Acronyms and Abbreviations

ARAR	applicable or relevant and appropriate requirement
Bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CLEAN	Comprehensive Long-term Environmental Action—Navy
CTO	Contract Task Order
DGM	digital geophysical mapping
DOI	United States Department of the Interior
EE/CA	Engineering Evaluation/Cost Analysis
EMA	Eastern Maneuver Area
EQB	Environmental Quality Board
ERA	ecological risk assessment
ERP	Environmental Restoration Program
FS	Feasibility Study
ft	foot/feet
HHRA	human health risk assessment
IC	institutional controls
IRP	Installation Restoration Program
LUCs	Land Use Controls
MD	munitions debris
MEC	munitions and explosives of concern
MOV	Municipality of Vieques
MPPEH	material potentially presenting an explosive hazard
msl	mean sea level
NASD	Naval Ammunition Support Detachment
NAVFAC	Naval Facilities Engineering Command, Atlantic Division
Navy	Department of the Navy
NCP	National Oil and Hazardous Substance Pollution Contingency Plan (National Contingency Plan)
NTCRA	Non-Time-Critical Removal Action
OB/OD	open burn/open detonation
PA/SI	Preliminary Assessment/Site Investigation
RI	Remedial Investigation
RRD	range-related debris
SARA	Superfund Amendments and Reauthorization Act
SI	Site Inspection
SWMU	Solid Waste Management Unit
U.S.	United States
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
UXO	unexploded ordnance
VNTR	Vieques Naval Training Range

SECTION 1

Introduction

This Engineering Evaluation/Cost Analysis (EE/CA) report presents the evaluation of interim removal action alternatives for a non-time critical removal action (NTCRA) to reduce the explosive hazard associated with potential munitions and explosives of concern (MEC) at Solid Waste Management Unit (SWMU) 4, located at the former Vieques Naval Ammunition Support Detachment (NASD), Vieques, Puerto Rico (**Figure 1-1**). This NTCRA will ultimately support the final remedy selection for the site and will facilitate near-term public access.

In 2012, a Proposed Remedial Action Plan was issued for public comment. Based on public comment, additional investigations are planned for SWMU 4 to support final remedy determinations. However, in order to address explosive hazard in the short term and expedite public access to portions of the site while the additional investigations continue, this NTCRA is planned to address the explosive hazards in the areas planned for public access.

This NTCRA addresses potential explosive hazards associated with the potential presence of munitions at:

- Areas planned for public access by the land owner (United States Department of Interior [DOI])
- Primary source areas (open burn/open detonation [OB/OD] pits)
- Areas where land crabbing occurs or is likely to occur

Risks associated with chemical contamination are not addressed as part of this NTCRA, but will be addressed as part of the final remedy for SWMU 4.

This report was prepared under the Naval Facilities Engineering Command, Atlantic Division (NAVFAC), Comprehensive Long-term Environmental Action—Department of the Navy (Navy) (CLEAN) 8012 Contract N62470-11-D8012, Contract Task Order (CTO) 005, for submittal to NAVFAC, the United Stated (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 CERCLA Environmental Restoration Program (ERP) Technical Subcommittee.

This document was prepared in general accordance with USEPA's guidance provided in document 540/R93/057 *Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA* (USEPA, 1993). Submittal of this document fulfills the requirements for a NTCRA defined by CERCLA, Superfund Amendments and Reauthorization Act (SARA), and the National Oil and Hazardous Substance Pollution Contingency Plan (National Contingency Plan) (NCP). The report was prepared to ensure it contains the information pertinent to an EE/CA, but in a format that facilitates an expedited review process and, as requested by EQB, accelerated public access to areas of the site planned for public access.

R:\USNAVFACENGCOM405450\VIEQUES\MAPFILES\SWMU_4_ENGINEERING_EVALUATION_COST_ANALYSIS\FIGURE 1-1 - REGIONAL LOCATION MAP.MXD CELEFTHERIADIS 1/3/2014 7:36:36 AM

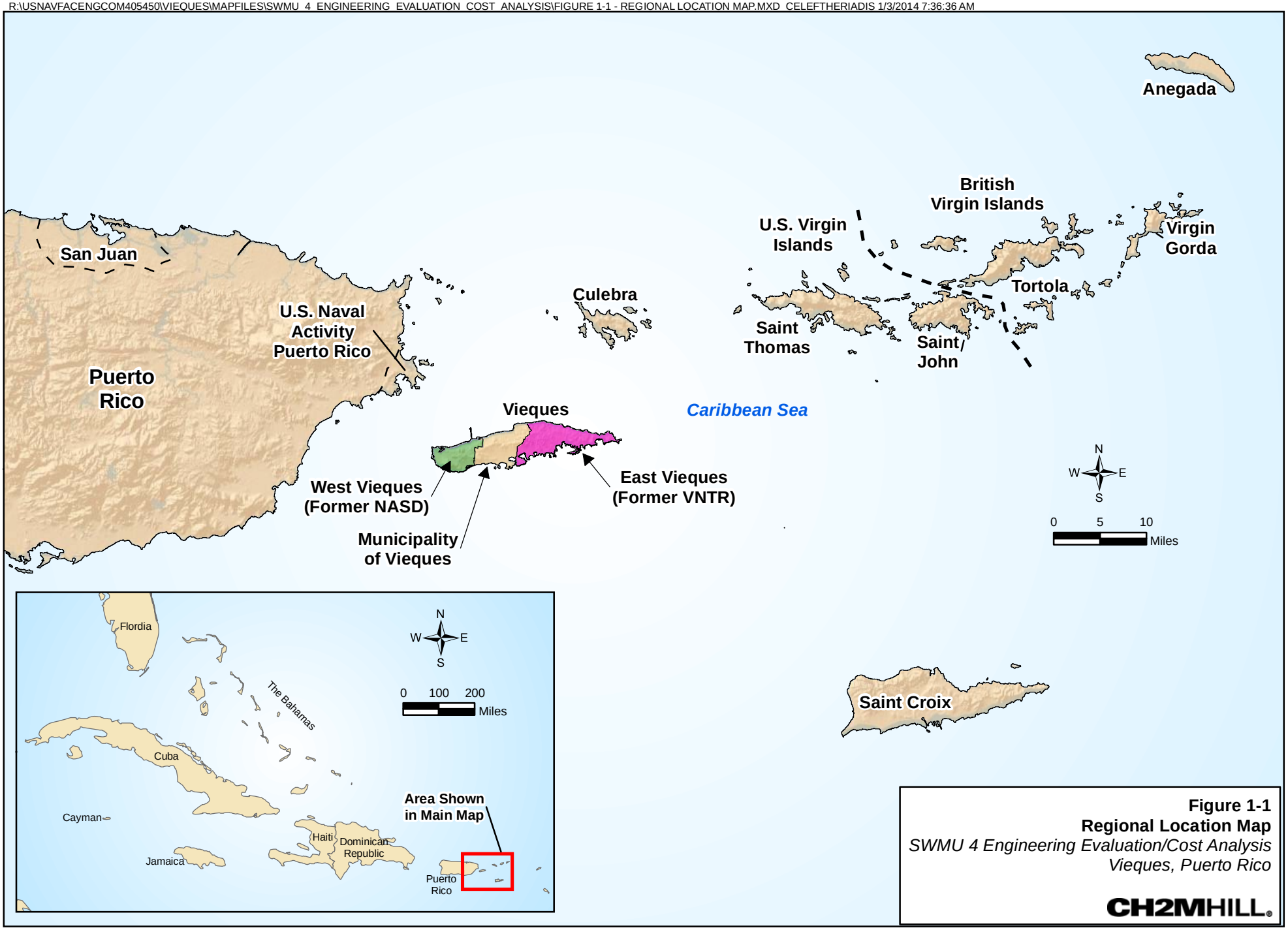

Figure 1-1
Regional Location Map
SWMU 4 Engineering Evaluation/Cost Analysis
Vieques, Puerto Rico

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SECTION 2

Site Characterization

2.1 Site Description and Background

- Vieques is located in the Caribbean Sea and is the largest offshore island of the Commonwealth of Puerto Rico; it is approximately 20 miles long and 4.5 miles wide (**Figure 1-1**).
- SWMU 4 is known as the former OB/OD Site that was used for the thermal destruction of retrograde and surplus munitions, fuels, and propellants from 1969 through 1979 and may have periodically been used as far back as the late 1940s. Fuels, propellants, and explosives waste materials were burned and/or detonated in 16 OB/OD pits that ranged in size from 10 to 25 feet across with depths ranging from 3 to 5 feet below grade. Operation activities resulted in the distribution of kick-outs and explosive fragments, distributing over an area based on the amount of explosives that were used and the type of munitions destroyed; a conservative, land-based safety buffer arc with a 3,000 foot (ft) radius from the pits defines the boundary of the site (**Figure 2-1**).
- SWMU 4 is approximately 400 acres in size (**Figure 2-1**). The offshore portion within the 3,000 ft buffer zone is part of Unexploded Ordnance (UXO) 16, which is being investigated as part of an Expanded Site Inspection. The NTCRA covered by this EE/CA includes only the terrestrial portion of the area within the safety buffer (i.e., SWMU 4).
- The Navy ceased facility-wide operations on the former NASD on April 30, 2001, when the land was transferred to the 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) and amended by Section 1049 of the National Defense Authorization Act for Fiscal Year 2002 (Public Law 107-107). The division of land among these entities is shown in **Figure 2-2**.
- The site is currently managed and protected as a wildlife refuge by the DOI's USFWS Caribbean Division. Due to the potential presence of MEC, non-authorized access to the site is currently discouraged by fences; locked, gated road with signage; and landscape features (i.e., dense vegetation).
- As indicated in **Figure 2-2**, the proposed land use plan developed by USFWS for SWMU 4 includes an observation tower and associated trail for nature observation and other recreational activities, including beach use, a scenic road, parking area, and picnic area. However, locations of the proposed land use activities are approximate and subject to change. Additionally, the beaches are monitored to preserve sea turtle nesting habitats. Any consideration of land transfers within the refuge or use other than as a national wildlife refuge would require specific congressional approval.
- In addition to the authorized land use, SWMU 4 is, and is expected to remain, subject to land crabbing. Land crabbers primarily use the existing road to access the site and then access areas around the lagoon. Access to the site is by foot or on horseback due to unmaintained roads and heavy vegetation.

2.2 Physical Characteristics

- The ground elevation at SWMU 4 ranges from 50 meters (164 ft) above mean sea level (msl) at the slope of Mount Pirata to sea level at the Laguna Boca Quebrada and the Caribbean Sea (**Figure 2-3**). The primary surface water body within SWMU 4 is the 62-acre Laguna Boca Quebrada. Surface water is also often present where the terminus of the main ephemeral stream is blocked from direct discharge to the ocean. All other surface water is intermittent, present only during and immediately following significant precipitation events.
- SWMU 4 is heavily vegetated with a high density of thorny shrubs throughout the site; mangroves occur around the edge of Laguna Boca Quebrada (mangrove clearance is not anticipated during the NTCRA).

- Where bedrock is not encountered at the surface, the soil at SWMU 4 occurs to a depth of approximately 2 feet below ground surface (bgs). The subsurface geology beneath SWMU 4 is characterized by saprolite, a clay-rich, decomposed rock that is formed in place by chemical weathering of volcanic rocks in tropical climates (CH2M HILL, 2012a).
- Groundwater flows generally westward within the saprock toward the coastline and Laguna Boca Quebrada.
- Four cultural and archeological resources were identified within SWMU 4 during archaeological surveys.

2.3 Previous Investigations and Removal Actions

- Between 1984 and 2000, the Initial Assessment Study (Greenleaf, 1984), Environmental Baseline Survey (Program Management Company, 2000), and Preliminary Assessment/Site Investigation (PA/SI) (CH2M HILL, 2000) were conducted at the NASD and identified SWMU 4 as an area requiring further investigation.
- From January 2002 to July 2003, the MEC component of the SWMU 4 Remedial Investigation (RI) was conducted to characterize the nature and extent of surface and subsurface MEC. MEC was removed from up to 1 ft bgs within an 87-acre area, including the OB/OD pits (**Figure 2-4**) (CH2M HILL, 2012a).
- From January 2007 to July 2008, the SWMU 4 RI was performed to characterize the nature and extent of chemical contaminants in soil, groundwater, and the surface water and sediment of the lagoon (Laguna Boca Quebrada) and ephemeral streams (CH2M HILL, 2012a).
- From October 2009 to June 2010, a NTCRA was conducted to remove MEC from the ground surface and to a maximum depth of 2 ft bgs and 4 ft bgs along the site roads and beaches, respectively (**Figure 2-4**) (CH2M HILL, 2012b).

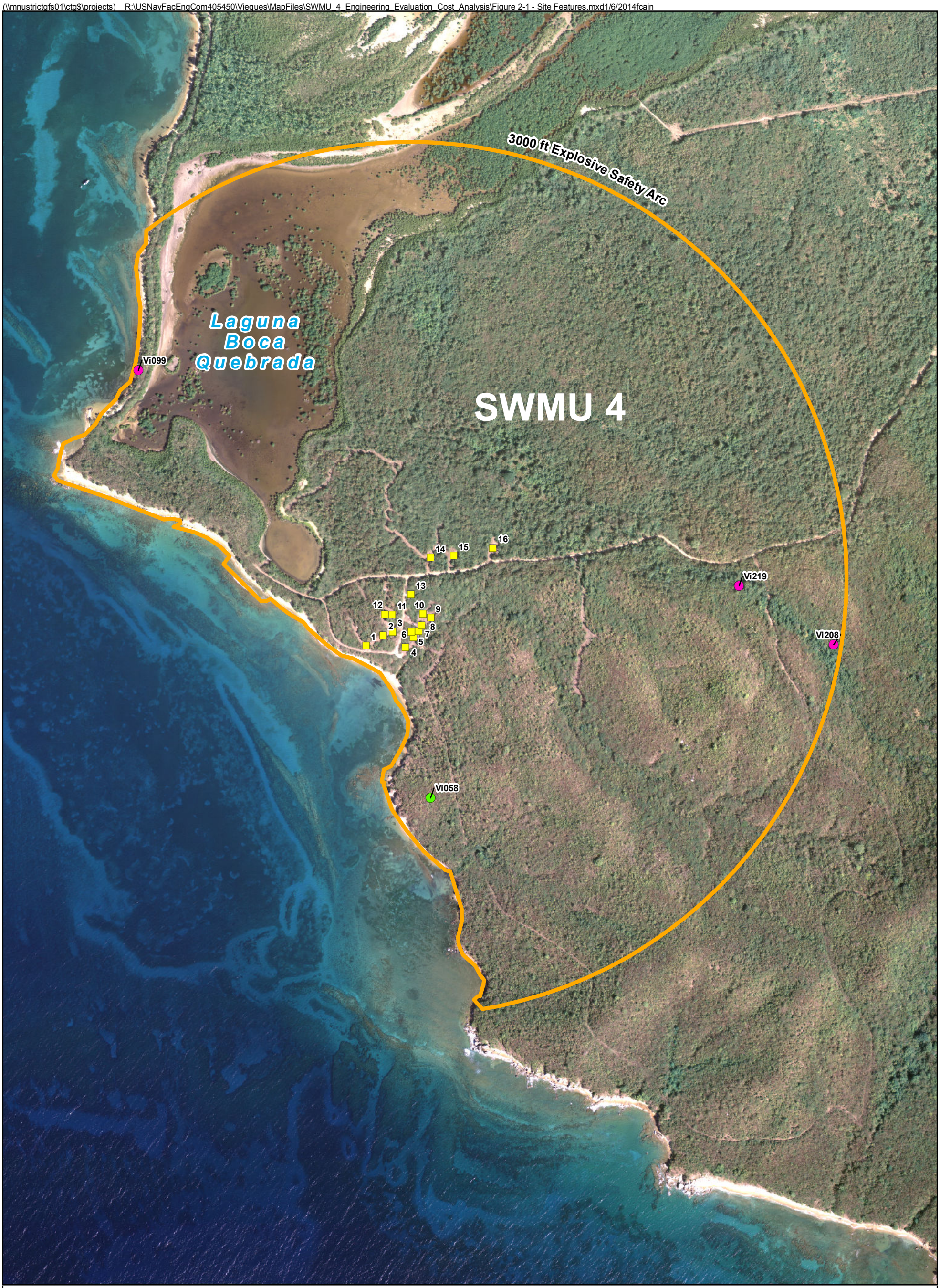
2.4 Nature and Extent of MEC Contamination

- Based on the findings of the previous removal actions and RI activities and the land use plan developed by USFWS, the nature and extent of MEC and material potentially presenting an explosive hazard (MPPEH) (and related debris) have been characterized sufficiently within the source area and accessed (current and planned) areas of the site to perform a NTCRA for these areas.
- The majority of the MEC recovered from SWMU 4 to-date have been 20 mm projectiles that contained or may have contained high explosive filler, tracers, fuzes, or a combination of each. Incendiary, white phosphorous, flares, fuzes, and small cartridges were also demilitarized/demolished by detonation at SWMU 4.
- MEC, MPPEH, munitions debris (MD), and range-related debris (RRD) occurred most frequently in the vicinity of the OB/OD pits with the density of items reducing with distance from the pits. MEC was not identified beyond approximately 2,600 ft from the OB/OD area. The distribution and density of MEC recovered from the site to-date is shown on **Figure 2-4**.
- During both the RI and the NTCRA for the roads and beaches, over 90 percent of the MEC recovered were found within the first 1 ft of excavation.

2.5 Evaluation of Risk

- A human health risk assessment (HHRA) and ecological risk assessment (ERA) were conducted as part of the RI. MEC and MPPEH potentially remaining onsite pose an explosive hazard to potential human receptors at the site. Other than threatened and endangered species, ecological receptors are not applicable to exposure considerations for MEC/MPPEH. The beaches represent potential threatened and endangered turtle species nesting habitat, but the beaches were cleared of MEC to a maximum depth of 4 feet during the associated NTCRA previously conducted and as such, area not included in this NTCRA.

(\\mnustrictgfs01\ctg$\projects) R:\USNavFacEngCom405450\Vieques\MapFiles\SWMU_4_Engineering_Evaluation_Cost_Analysis\Figure 2-1 - Site Features.mxd1/6/2014fcain



Legend

- OB/OD Pits
- Archaeological Site Surveyed but not Evaluated
- Archaeological Site with no Significance
- SWMU 4 Site Boundary

Note:
'8' - OB/OD Pit Number
2007 Aerial Imagery

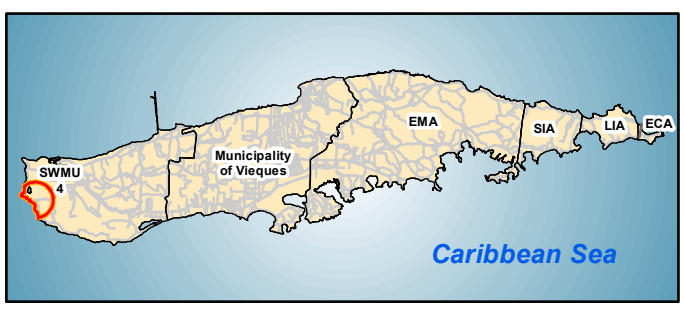


Figure 2-1
Site Features
SWMU 4 Engineering Evaluation/Cost Analysis
Vieques, Puerto Rico

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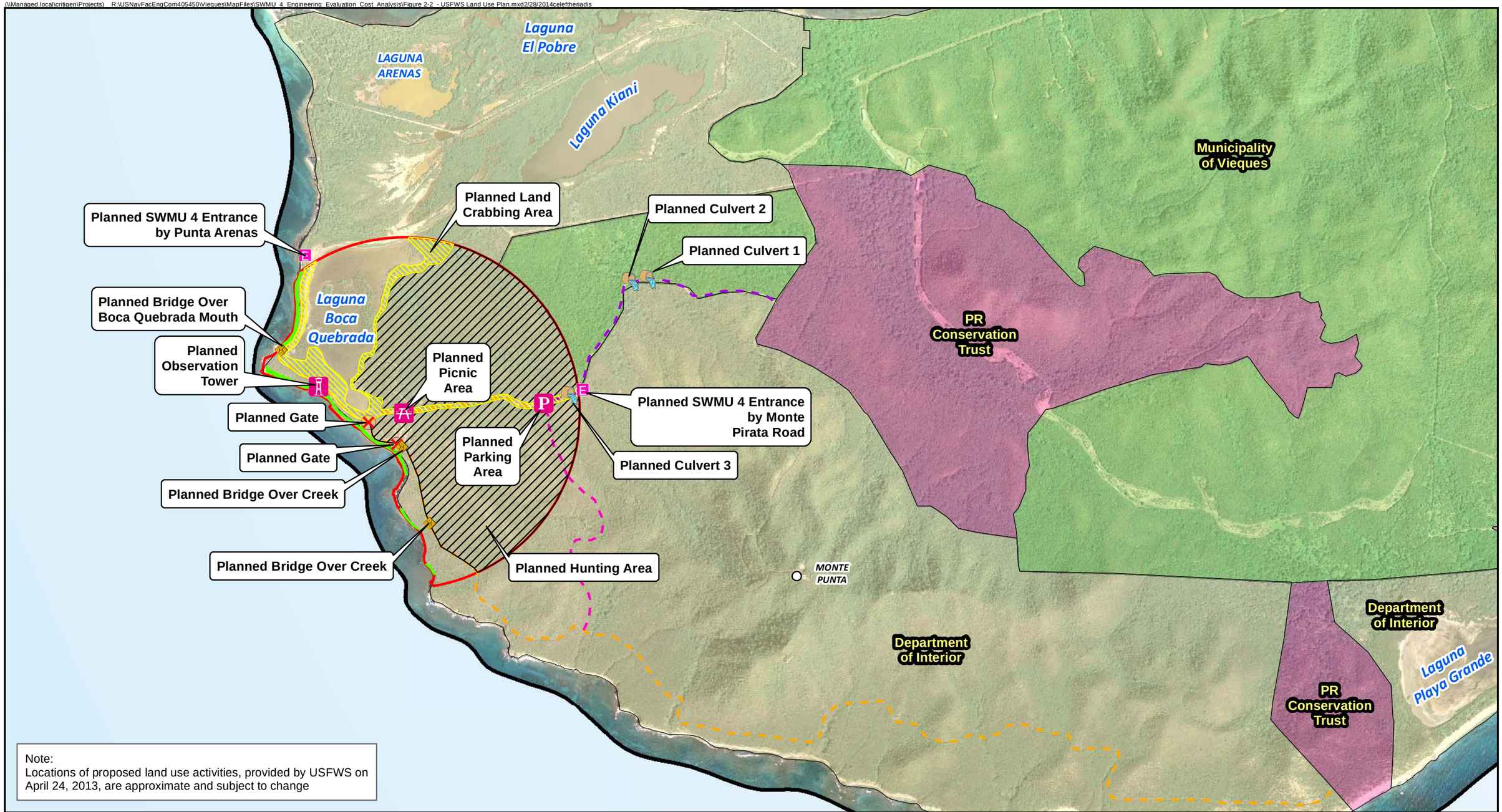
(\\Managed.local\critigen\Projects) R:\USNavFacEngCom405450\Vieques\MapFiles\SWMU_4_Engineering_Evaluation_Cost_Analysis\Figure 2-2 - USFWS Land Use Plan.mxd2/28/2014celeftheriadis



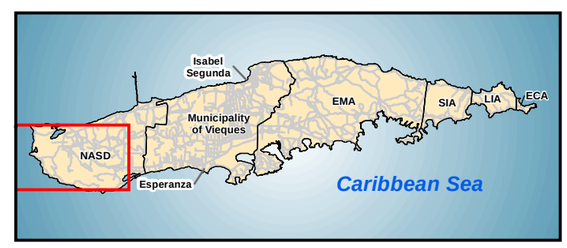
Note:
Locations of proposed land use activities, provided by USFWS on April 24, 2013, are approximate and subject to change

Legend

- Bridge
- Culvert
- Entrance
- Gate
- Planned Observation Tower
- Planned Parking Area
- Planned Picnic Area
- Planned Vehicle Road
- Planned Hiking/Biking Trail
- Planned Hiking/Bird Watching Trail
- Sea Turtle Nesting and Monitoring Beach
- Planned Hunting Area
- Planned Land Crabbing Area
- SWMU 4 Boundary

Vieques Land Ownership

- Department of Interior
- Municipality of Vieques
- PR Conservation Trust



N W E S

0 1,000 2,000 Feet

Figure 2-2
USFWS Land Use Plan
SWMU 4 Engineering Evaluation/Cost Analysis
Vieques, Puerto Rico

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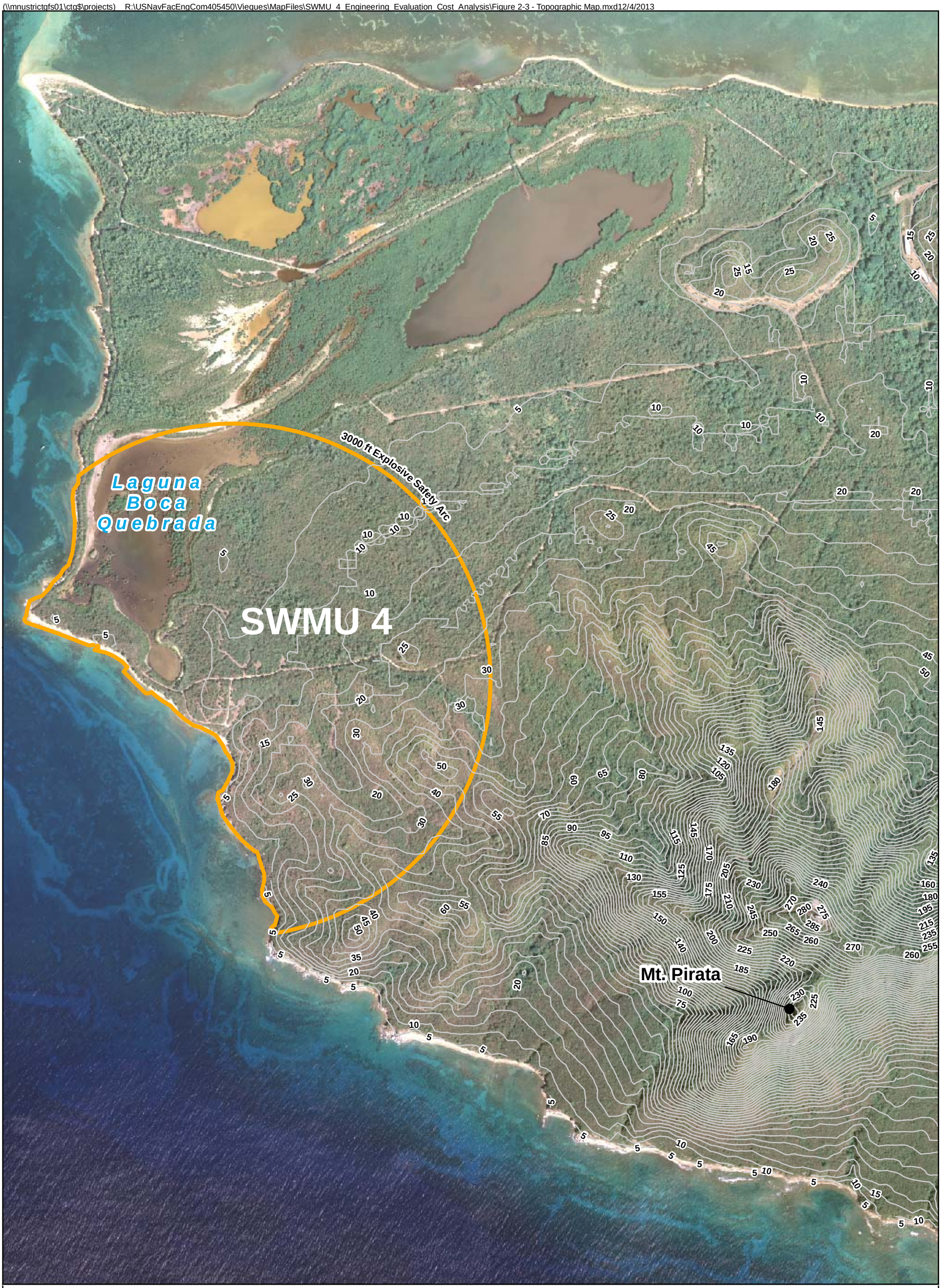
(\\mnustrictgfs01\ctg$\projects) R:\USNavFacEngCom405450\Vieques\MapFiles\SWMU_4_Engineering_Evaluation_Cost_Analysis\Figure 2-3 - Topographic Map.mxd12/4/2013



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Topographic Contours (5 Meter)

SWMU 4 Site Boundary

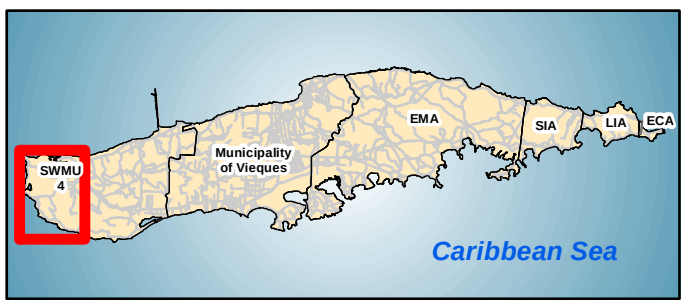

Figure 2-3
Topographic Map
SWMU 4 Engineering Evaluation/Cost Analysis
Vieques, Puerto Rico

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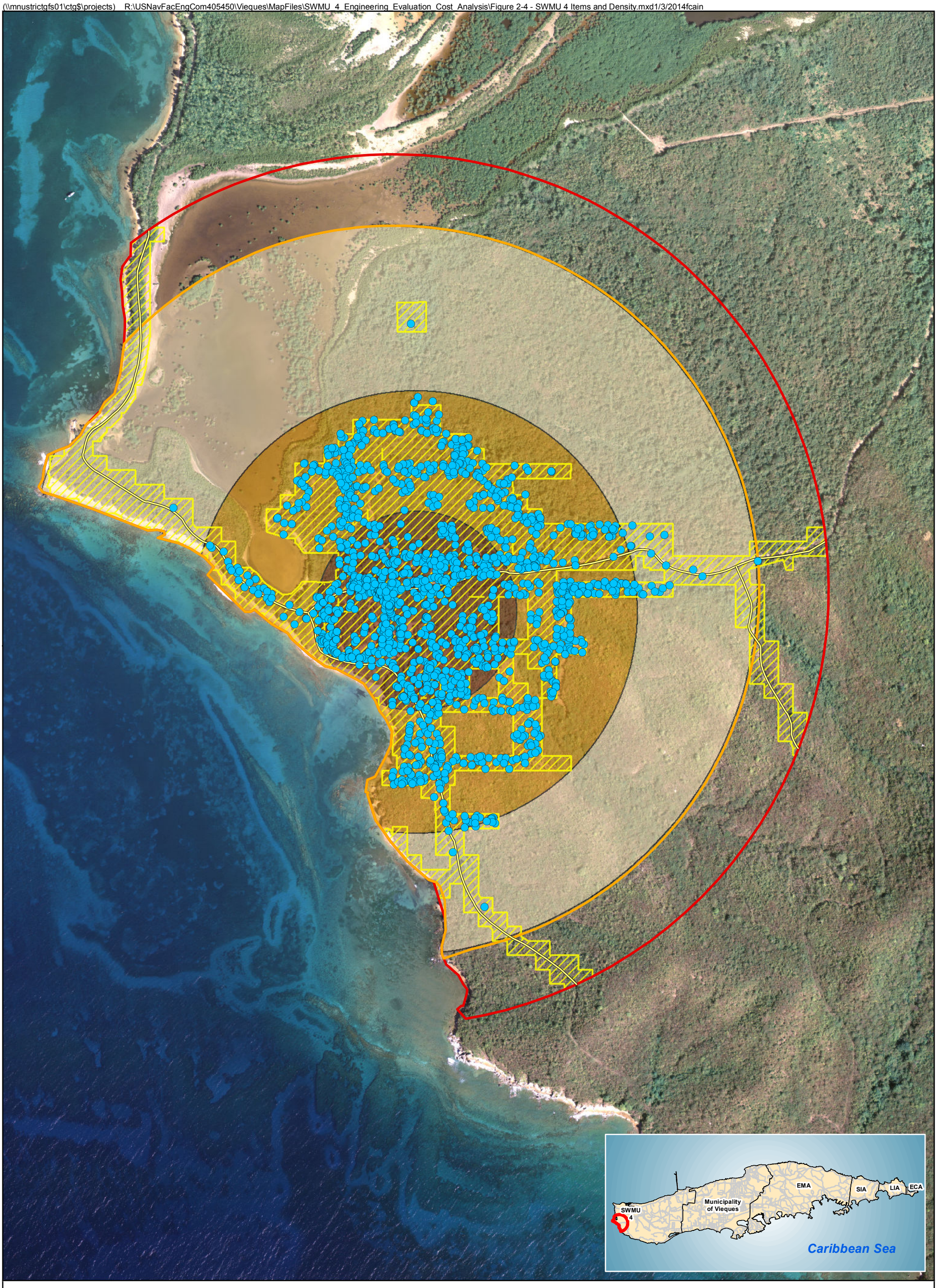
(\\mnustrictgfs01\ctg$\projects) R:\USNavFacEngCom405450\Vieques\MapFiles\SWMU_4_Engineering_Evaluation_Cost_Analysis\Figure 2-4 - SWMU 4 Items and Density.mxd1/3/2014fcain



Legend

- MEC/MPPEH Item
- Road
- Estimated MEC/MPPEH Density less than 5 per acre
- Estimated MEC/MPPEH Density between 5 and 15 per acre
- Estimated MEC/MPPEH Density greater than 15 per acre
- Areas Previously Cleared of MEC
- Projected Extent of MEC
- SWMU 4 Site Boundary

2007 Aerial Imagery

N W E S

0 300 600 Feet

Figure 2-4
MEC Items and Estimated MEC/MPPEH Densities
SWMU 4 Engineering Evaluation/Cost Analysis
Vieques, Puerto Rico

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SECTION 3

Removal Action Objective and Scope

3.1 Statutory Limits on Removal Actions

The NCP 40 Code of Federal Regulations (CFR) Part 300.415 dictates statutory limits of $2 million and 12 months of USEPA fund-financed removal actions, with statutory exemptions for emergencies and actions consistent with the remedial action to be taken. This removal action will not be USEPA fund-financed. The Navy/Marine Corps Installation Restoration Program (IRP) Manual does not limit the cost or duration of the removal action; however, cost-effectiveness is a recommended criterion for the evaluation of removal action alternatives.

3.2 Applicable or Relevant and Appropriate Requirements

The selected removal action will comply with applicable or relevant and appropriate requirement (ARARs) under federal and Puerto Rico laws. **Appendix A** contains the ARAR tables and provides a summary of each potentially related environmental and munitions regulation. Other federal and Puerto Rico advisories, criteria, or guidance will be considered, as appropriate, in formulating the removal action.

3.3 Removal Action Objectives and Scope

The goal of this EE/CA and subsequent interim action is to accelerate public access to the areas intended for such use in the USFWS land use plan (**Figure 2-2**), while the site as a whole continues through the full CERCLA process. The site-specific RAOs for this NTCRA are:

- Reduce the potential explosive hazard associated with the areas intended for public use
- Reduce the potential explosive hazard associated with the areas likely accessed for land crabbing
- Reduce the potential for unauthorized access to the restricted areas of the site

3.4 Determination of Removal Action Schedule

The EE/CA will be placed in the Administrative Record and notice of its availability for public review along with a brief summary will be published in the local newspaper. The EE/CA will then be available for a 45-day public comment period. Following the public comment period, a Responsiveness Summary will be prepared that summarizes responses to significant comments and will be included in the Administrative Record. Since this removal action has been designated non-time-critical, the start date will be initiated following the resolution of the comments.

The total project period is anticipated to span an estimated 10 to 12 months, from the end of the public comment period through completion of the selected removal action. This is an estimated schedule for project completion; should critical milestones not be met, the total project timeframe would also be extended. Critical milestone periods related to the EE/CA are summarized below:

- EE/CA Public Comment Period—45 days
- Contracting and site preparation—3 months
- NTRCA — 7-9 months (this is highly variable and contingent upon the remedy selected, site conditions, availability of the work force and project materials, weather, and other external influences)

SECTION 4

Identification and Detailed Analysis of Removal Action Alternatives

4.1 Alternatives Description

Based on the information presented in Section 2 and RAOs presented in Section 3, the following removal action alternatives have been considered for detailed evaluation at SWMU 4:

1. No Action
2. Munitions Removal from Planned Public Areas and Other Likely Accessed Areas, Hazard Warning Signs, and Educational Kiosks
3. Munitions Removal from Planned Public Areas, Hazard Warning Signs, Educational Kiosks, and Confirmatory MEC Extent Determination

A description of each of these alternatives is provided below. An alternative consisting solely of Land Use Controls (LUCs) and Institutional Controls (ICs) was considered but not evaluated further because the Technical Subcommittee concurred that this alternative would not meet the protectiveness objectives. However, LUCs and ICs are an integral part of all alternatives (other than No Action).

4.1.1 Alternative 1—No Action

- The no action alternative consists of leaving the site as it currently is, with no additional removal actions or land use controls.

4.1.2 Alternative 2—Munitions Removal from Planned Public Areas and Other Likely Accessed Areas, Hazard Warning Signs, and Educational Kiosks

- This alternative will address the areas with the highest potential for there to be incidental contact with MEC, which are those that are and will be open to the public and those that are likely to be accessed for land crabbing. These areas are shown in **Figure 4-1** and include:
  - **0.5-acre OB/OD Pits and Observation Tower Area** – Surface and subsurface MEC removal at each of the 16 OB/OD Pits and at the Observation Tower (10 meters squared area) to the total subsurface depth of MEC identified using digital geophysical mapping (DGM) and subsequent intrusive investigations. The OB/OD pits have the highest potential for subsurface MEC at the site.
  - **2-acre Planned Parking and Picnic Area**- Surface and subsurface MEC removal to a maximum depth of 2 ft bgs using DGM and subsequent intrusive investigations. The depth of 2 ft was selected based on the likely depth of disturbance for future construction/land management activities, to provide a buffer to minimize the exposure of MEC from soil erosion, and to minimize the explosive hazard based on the occurrence of MEC primarily observed within the top 1 ft bgs at the site (with conservative additional foot).
  - **18.5-acre Lagoon Fringe Area**- Surface and subsurface MEC removal to a maximum depth of 1 ft bgs using a “mag and dig” approach in accessible areas. The depth of 1 ft was selected because previous findings showed the occurrence of MEC at SWMU 4 was primarily in the top 1 ft due to the release mechanism (i.e., kick-outs).
- Manual and/or mechanical vegetation removal will be performed throughout the NTCRA area (other than the lagoon fringe where no vegetation removal is planned to occur) to safely access and remove MEC. Cut vegetation will be left on site to naturally degrade. No vegetation removal will be performed within the lagoon fringe because the objective in that area is to remove MEC from the areas that are accessed.

- The OB/OD Pit Area and the Parking, Picnic, and Observation Tower Area will be allowed to naturally re-vegetate.
- The access roads to the site will require repairs to allow the MR contractors sufficient access to the site during the NTCRA.
- Signs will be installed throughout the accessed areas of SWMU 4 to inform the public that access to the restricted area of the site is prohibited and potentially dangerous. For the purposes of this EE/CA, it is assumed that 42 signs will be installed along the site roads and along the lagoon fringe. The actual number of signs and associated sign language will be included in the Interim Removal Action Work Plan. The signs will be installed when the roads are prepared for public access.
- Educational kiosks will be installed containing information about SWMU 4 and MEC awareness information. For the purposes of this EE/CA, it is assumed these kiosks will be installed at the two primary entrances to SWMU 4 (the gated entrance south of Punta Arenas [Green Beach] and the parking area). The kiosks will be installed with the support of UXO avoidance personnel when the roads, picnic/parking areas, and entrances are prepared for public access. The actual number of kiosks and associated kiosk language will be included in the Interim Removal Action Work Plan.
- In order to facilitate the repair/maintenance of the road and other areas planned for access, UXO avoidance procedures will be implemented in the event intrusive activities are necessary. The UXO avoidance procedures will require that UXO Technicians carefully inspect the area with the aid of an appropriate geophysical instrument (e.g., Schonstedt GA-52CX magnetometer or similar) for evidence of a metallic object on or beneath the ground surface. Details of the avoidance procedures will be documented in the Land Use Control Implementation Plan that will be prepared with the Interim Removal Action Work Plan.

4.1.3 Alternative 3—Munitions Removal from Planned Public Areas, Hazard Warning Signs, Educational Kiosks, and Confirmatory MEC Extent Determination

- This alternative is the same as Alternative #2 but includes intrusively investigating a 24-acre area of "spokes," which originate at the boundary of past MEC removal activities near the OB/OD pits and extend to the site boundary (see **Figure 4-2**). The "spokes" will serve to support future remedial action evaluations and decisions for the site, as they are expected to confirm the extent of munitions items across SWMU 4 and may be used to refine the area addressed by the final remedy for the site.
- Vegetation removal will be conducted in manner similar to Alternative 2 to safely access and remove MEC.
- The spokes will be intrusively investigated using mag and dig techniques to a maximum depth of 1 ft bgs.

4.2 Evaluation of Alternatives

The alternatives were evaluated in detail using the NCP evaluation criteria (40CFR300.430(e)(9)). Detailed evaluations of the alternatives are presented in **Table 4-1**. The alternative cost estimates are in 2013 dollars, based on RS Means and engineer's estimates for similar projects. It should be noted that the costs in **Tables 4-2 and 4-3** do not include periodic monitoring and maintenance costs associated with the signs and kiosks.

The cost estimates presented in **Tables 4-2 and 4-3** have been developed strictly for comparing the removal 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.

The cost estimates are order-of-magnitude estimates having an intended accuracy range of +50 to -30 percent. The range applies only to the alternatives as they are defined herein and does not account for changes in the scope of the alternatives.

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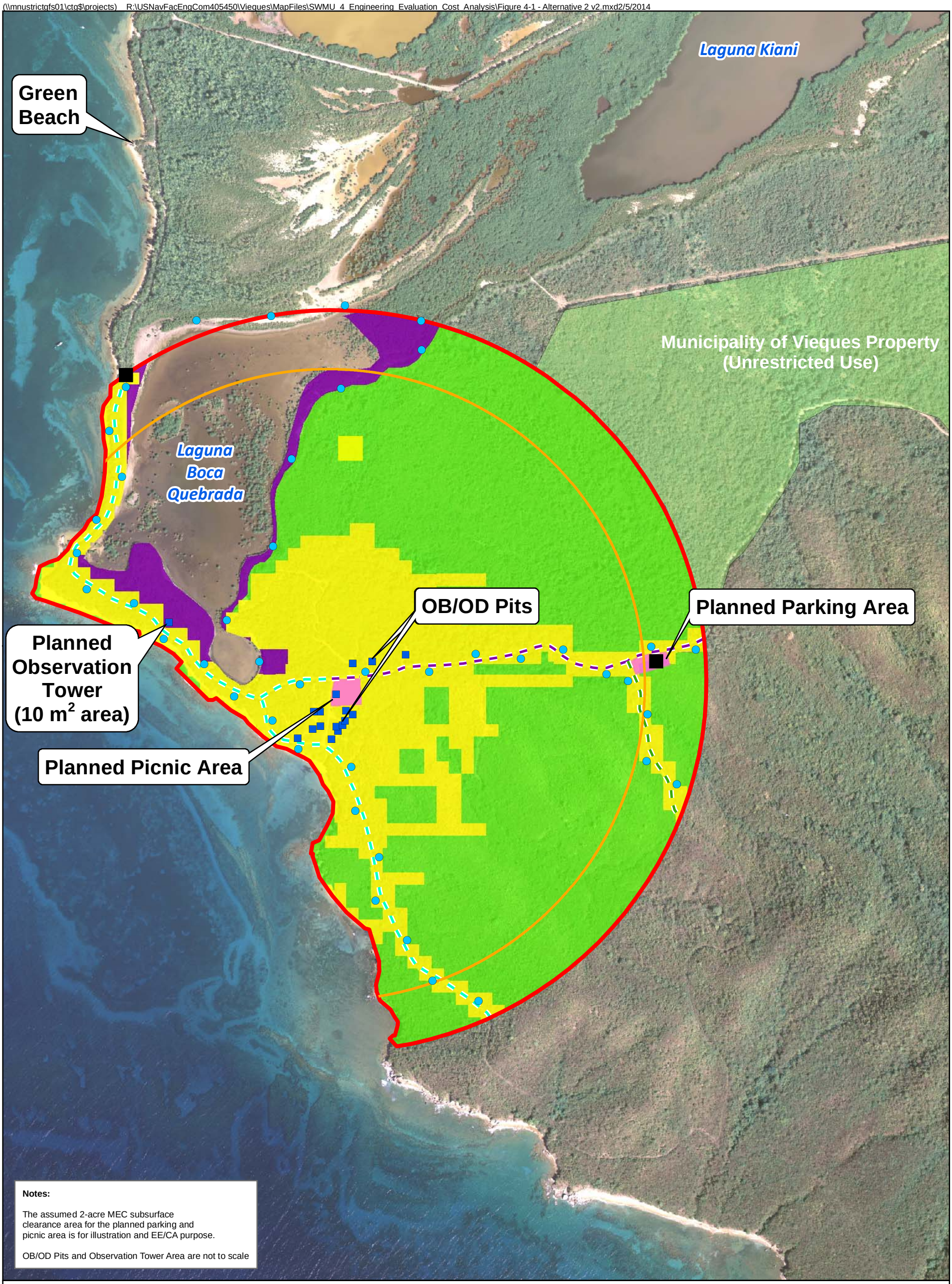


Legend

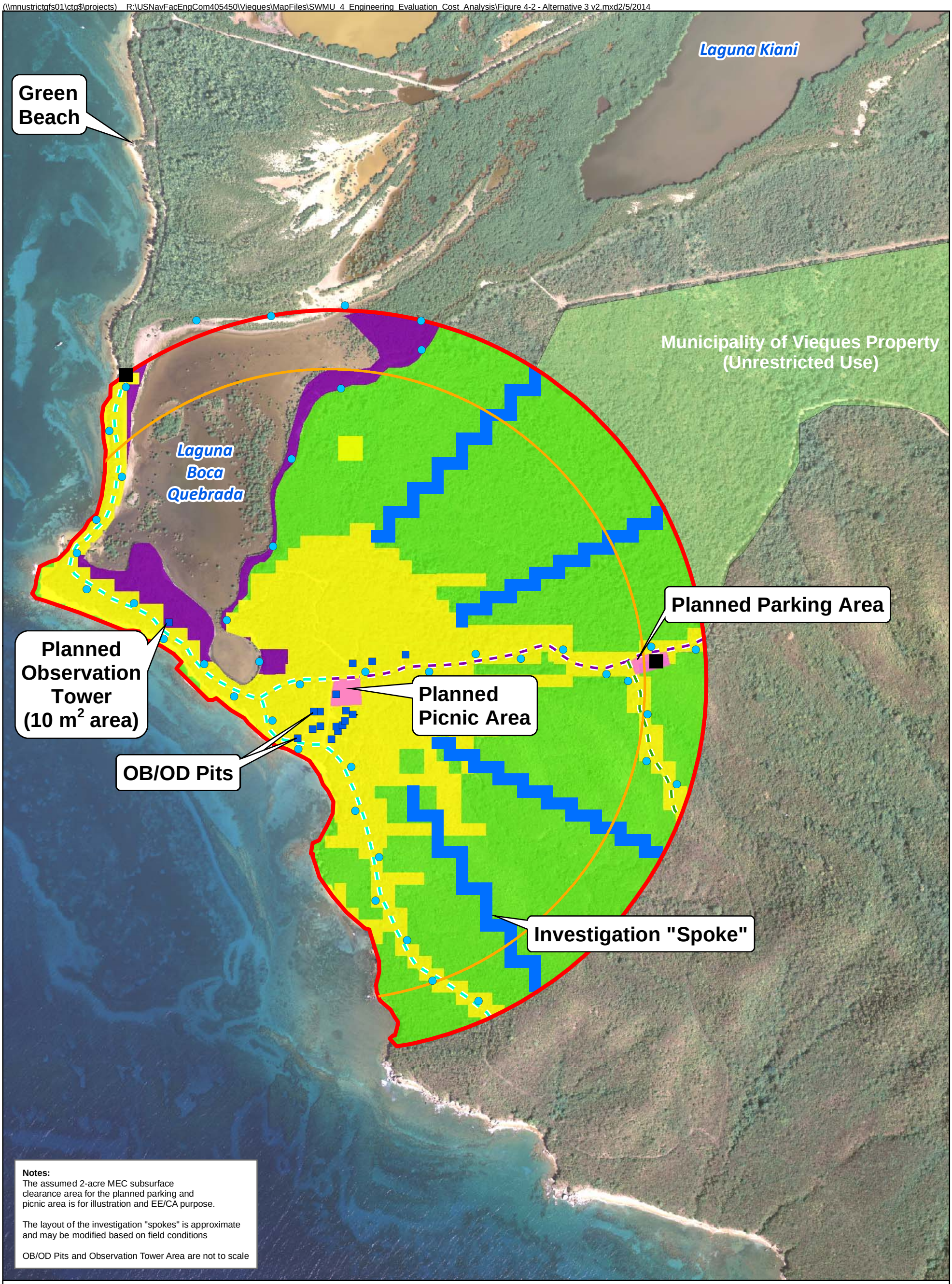
- SWMU 4 Boundary
- Extent of MEC
- Planned Signage
- Planned Informational Kiosk
- Planned Vehicle Road
- Planned Hiking/Biking Trail
- Planned Hiking/Bird Watching Trail
- 0.5 acre OB/OD Pit and Observation Tower Area
- 18.5 - acre Lagoon Fringe Area
- 2 - acre Planned Parking and Picnic Areas
- Areas Previously Cleared of MEC
- Dense Vegetation

N W E S

0 500 1,000 Feet

Figure 4-1
Alternative 2 - Munitions Removal from Planned Public Areas, Hazard Warning Signs, and Educational Kiosks
SWMU 4 Engineering Evaluation/Cost Analysis
Vieques, Puerto Rico

(\\mnustrictqfs01\ctg$\projects) R:\USNavFacEngCom405450\Vieques\MapFiles\SWMU_4_Engineering_Evaluation_Cost_Analysis\Figure 4-2 - Alternative 3 v2.mxd2/5/2014



Legend

- SWMU 4 Boundary
- Extent of MEC
- Planned Signage
- Planned Informational Kiosk
- Planned Vehicle Road
- Planned Hiking/Biking Trail
- Planned Hiking/Bird Watching Trail
- 0.5 acre OB/OD Pit and Observation Tower Area
- 18.5 - acre Lagoon Fringe Area
- 2 - acre Planned Parking and Picnic Areas
- 30 - acre Investigation "Spoke" Area
- Areas Previously Cleared of MEC
- Dense Vegetation

N W E S

0 500 1,000 Feet

Figure 4-2
Alternative 3 - Munitions Removal from Planned Public Areas, Hazard Warning Signs, Educational Kiosks, and Confirmatory Munitions Characterization
SWMU 4 Engineering Evaluation/Cost Analysis
Vieques, Puerto Rico

SECTION 5

Comparative Analysis of Removal Action Alternatives

A summary of the relative comparative analysis is provided in **Table 5-1.**

5.1 Overall Protection of Human Health and the Environment

- Alternatives 2 and 3 are protective of human health and the environment because they will remove potential MEC from the site and they will implement LUCs to minimize the explosive hazard associated with the potential for contact with MEC within other areas of SWMU 4.

5.2 Compliance with ARARs

- **Appendix A** presents a compilation and evaluation of state (Commonwealth) and federal chemical-specific, location-specific, and action-specific ARARs. All of the removal alternatives meet the ARARs.

5.3 Long-Term Effectiveness and Permanence

- Alternative 1 does not provide any long-term effectiveness.
- Alternatives 2 and 3 effectively address MEC within the NTCRA areas. These alternatives also rely on LUCs and ICs to reduce the potential for exposure to MEC that may remain at the site. While both of these alternatives are effective, Alternative 3 provides an additional level of long-term effectiveness because it provides additional information on the radial extent of MEC out from the OB/OD pits that will improve the final remedy evaluation and determination.

5.4 Reduction of Toxicity, Mobility, and Volume through Treatment

- There is no reduction in toxicity, mobility, and volume associated with Alternative 1.
- Reduction of mobility and volume through treatment will be accomplished through Alternatives 2 and 3 by removal and destruction of any MEC identified. Alternative 3 will likely be slightly more effective at reducing the volume and mobility of MEC and potential MC, as the “spokes” will add to the overall area addressed by the NTCRA.

5.5 Short-Term Effectiveness

- Because there would be no removal activities associated with Alternative 1, this alternative has the least short-term impacts. Alternatives 2 and 3 will present potential short-term impacts to workers at the site and to USFWS personnel needing to access the site for refuge management activities, but these can be managed through MEC health and safety practices and, as applicable, MEC avoidance and escort procedures. Minimal impacts to the general public are anticipated during the NTCRA. The work area is in a remote area of Vieques that is currently closed to the public. However, potential impacts, including explosive hazard, noise, and residue dust from munitions detonated, would be minimal. There will also be minimal impact to the community from traffic to transport materials to the site.
- Although worker safety would be relatively normal and manageable with respect to the typical munitions response activities on Vieques, the following safety concerns for workers will exist:
  - Working in an area with potentially live munitions is the main hazard to workers associated with Alternatives 2 and 3. All personnel involved with the removal actions will have the proper training and demonstrated experience for project roles and will receive site-specific training, including munitions

awareness training (often referred to as Recognize, Retreat, Report [3R] Training) as appropriate. Exclusion zones will be maintained throughout the removal action and only authorized personnel will be allowed in the exclusion zone.

  - The project area contains rough terrain in a tropical and vegetated environment. Proper planning, equipment, and task- and site-appropriate personal protective equipment can mitigate the health and safety concerns associated with these site conditions.

- Potential impacts to the environment are primarily associated with the removal of vegetation and ground disturbance associates with the MEC removal activities and sign and kiosk installation. To minimize these impacts, USFWS and DNER will be consulted about vegetation removal and erosion and sediment controls will be employed as appropriate. In addition, vegetation cutting in sensitive habitats (i.e., mangroves) will be minimized to the extent practicable so the UXO teams can safely and efficiently conduct the removal action.
- The timeframe to achieve the NTCRA RAOs is the anticipated duration of the NTCRA, which is 7 to 9 months.
- A sustainability estimate using the SiteWise™ tool determined that Alternatives 2 and 3 had comparable environmental footprints (**Appendix B**).

5.6 Implementability

- Since Alternative 1 is the No Action alternative and does not meet the RAOs, it would be difficult to obtain administrative approval for this alternative. Alternatives 2 and 3 are technically and administratively feasible using methodology commonly employed on Vieques.

5.7 Cost

- Alternative 1 is the most cost effective as there is no cost associated with it; however, this alternative does not meet the RAOs. The estimated cost of Alternative 2 is $2,523,000; the estimated cost of Alternative 3 is $4,340,000.

SECTION 6

Recommended Interim Removal Action Alternative

Alternative 3, Munitions Removal from Planned Public Areas, Hazard Warning Signs, Educational Kiosks, and MEC Extent Determination, is the recommended alternative. The following is the most significant factor used for making the recommendation:

- Alternative 2 and Alternative 3 have nearly the same “score” using the various NCP criteria. Alternative 3 has an additional cost associated with MEC identification and removal along the spokes, provides an additional level of explosive hazard reduction, and will provide a significant amount of information that can be used to improve the evaluation and ultimate selection of the final remedy for the site.

SECTION 7

References

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CH2M HILL, 2012a. *Final RI/FS Solid Waste Management Unit 4 (SWMU 4) Former Naval Ammunition Support Detachment, Vieques, Puerto Rico.* May.

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USEPA, 1993. *Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA.* August.

Appendix A
Applicable or Relevant and Appropriate Requirements

Table 1(a)
Federal Chemical-Specific ARARs
SWMU 4 Remedial Investigation/Feasibility Study Report
Former Naval Ammunition Support Detachment
Vieques, Puerto Rico

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

Table 1(b)
Puerto Rico Chemical-Specific ARARs
SWMU 4 Engineering Evaluation/Cost Analysis
Former Naval Ammunition Support Detachment
Vieques, Puerto Rico

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

Table 1(c)
Federal Location-Specific ARARs
SWMU 4 Engineering Evaluation/Cost Analysis
Former Naval Ammunition Support Detachment
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)	2 and 3	Applicable	Activities at SWMU 4 that will affect Puerto Rico's coastal zone will be consistent to the maximum extent practicable with Puerto Rico's enforceable policies. Activites performed on-site and in compliance with CERCLA are not subject to adminsitrative 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	2 and 3	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.

Table 1(d)
Puerto Rico Location-Specific ARARs
SWMU 4 Engineering Evaluation/Cost Analysis
Former Naval Ammunition Support Detachment
Vieques, Puerto Rico

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

Table 1(e)
Federal Action-Specific ARARs
SWMU 4 Engineering Evaluation/Cost Analysis
Former Naval Ammunition Support Detachment
Vieques, Puerto Rico

Action	Requirement	Prerequisite	Citation	Alternative	ARAR Determination	Comment
Management of non-hazardous solid waste onsite in containers or in 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.	40 CFR 273.3-1(a); 3-3; 3-4(a); 3-7(a); 3-8(d)	2 and 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.
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 and 3	Applicable	If any of the selected remedies or the combination thereof disturb greater than one acre of land a Storm Water Pollution Prevention Plan will be prepared and implemented. Since activities are taking place onsite and in compliance with CERCLA, the substantive requirements will be met, but a permit will not be requried.
Discharge of dredge-and-fill material	No discharge of dredged or fill material will be allowed unless appropriate and practicable steps are taken that minimize potential adverse impacts of the discharge on the aquatic ecosystem.	Discharges of dredged or fill material to surface waters, including wetlands.	40 CFR 230.10(d); 33 CFR 320.4(a), (b), (d), (p), (r)	2 and 3	Applicable	Care will be taken that intrusive investigations in close proximity to the lagoon do not result in placement of any material or wastes within wetland areas. Since this is an onsite CERCLA response action, the substantive requirements will be met, but a permit will not be required. A Compensatory Mitigation Plan will be prepared and compensatory mitigation will be performed if required.
Management of military munitons	Specifies management requirements for those military munitons 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 and 3	Applicable	If any military munitions lose their exemption from the definition of solid waste they will be handled in accordance with these rules.
Storage of fuels and oils (petroleum and non-petroleum) onsite	If storage capacity limits are exceeded a Spill, Prevention, Control, and Countermeasures Plan must be prepared and implemented with procedures, methods, equipment, and other requirements to prevent the discharge of into or upon the navigable waters of the United States.	Total onsite storage capacity exceeding 1,320 gallons in containers that are 55 gallons or larger in size. Empty or partially filled containers must still have their entire volume included in the summation.	40 CFR 112.1(b) through (d), 112.3 [excluding paragraph f], 112.5 through 8, and 12	2 and 3	Applicable	It is anticipated that fuels or other treatment chemicals will be stored onsite. If the storage capacity in containers that are 55 gallons or greater is equal to or exceeds 1,320 gallons a Spill Prevention, Control, and Countermeasure (SPCC) Plan must be prepared and implemented. Containers include oil (including those oils used for enhanced biodegredation) and fuel reservoirs in equipment.

Table 1(f)
Puerto Rico Action-Specific ARARs
SWMU 4 Engineering Evaluation/Cost Analysis
Former Naval Ammunitition Support Detachment
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 and 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 and 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 dBA.	Construction activity including earthwork	Puerto Rico Regulation 3418.3.1.5(A),(C);3.1.10; 3.1.13; and 4.1	2 and 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 and 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.

Appendix B
Sustainability Analysis for SWMU 4

APPENDIX B

Sustainability Analysis for SWMU 4

1.1 Introduction

This appendix presents the approach taken and results obtained from a sustainability analysis performed for Solid Waste Management Unit (SWMU) 4, located at the former Vieques Naval Ammunition Support Detachment, Vieques, Puerto Rico. A site description and history of SWMU 4 is provided in Section 2 of the Engineering Evaluation/Cost Analysis (EE/CA).

Non-time critical removal action (NTCRA) alternatives were developed to reduce the explosive safety risk associated with potential munitions and explosives of concern (MEC) at SWMU 4. A detailed summary of the remedial alternatives is provided in Section 4 of the EE/CA. A sustainability analysis was performed using SiteWise™ Version 3.0 (Battelle, 2013) for the following remedial alternatives:

- Alternative 1 - No Action
- Alternative 2 – Munitions Removal from Planned Public Areas, Hazard Warning Signs, and Educational Kiosks
- Alternative 3 – Munitions Removal from Planned Public Areas, Hazard Warning Signs, Educational Kiosks, and Confirmatory Munitions Characterization

1.2 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, such as: remedial investigation (RI), remedial action construction (RAC), remedial action operation (RAO), and long-term monitoring (LTM). For this analysis only the RAC phase was 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 (CO_2e), consisting of carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O)
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 (PM_{10})
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 EE/CA.

1.2.1 General Assumptions

The specific assumptions made for the individual remedies are presented in **Tables B-1** and **B-2**. 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. kiosks and signs), the transportation of these materials was captured using the EQUIPMENT TRANSPORTATION sections.
- Production of wood used for fencing or kiosks was estimated using the "very low impact material" option in SiteWise™.
- Munitions removal was assumed to be the same for both alternatives and was not included in this analysis.
- Personnel transportation to Vieques each month 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 heavy duty truck per day.
- Transportation is assumed to be shared (2 people per vehicle as specified in **Table B-1** and **B-2**).

1.3 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-3**). 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 Alternatives 2 and 3 is summarized in **Figure B-1**. **Table B-3** 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 except accident risk fatality. The footprints for Alternative 2 were also all given a rank of "high" because they were all greater than 90% percent of the maximum footprints, excluding the accident risk fatality footprint which was given a rank of low. Because the only difference between Alternative 3 and Alternative 2 is an additional week of field investigation, the environmental impacts of each alternative are almost identical. As previously discussed, a smaller footprint is more desirable. The footprints for each alternative are discussed below.

- Alternative 1— No Action
  This alternative was not considered because it involves no activity.
- Alternative 2 –Munitions Removal from Planned Public Areas, Hazard Warning Signs, and Educational Kiosks
  Transportation of personnel accounted for over 75% of GHG, total energy, total NO_X and total SO_X footprints. The 96 plane trips between the United States and Puerto Rico contributed significantly to these footprints. Equipment usage and transportation of personnel accounted for the majority of the PM_{10}. Water use was considered negligible and not included. Onsite labor hours accounted for the majority of accident risk fatality and injury footprints. Results are provided in **Table B-4**.

- Alternative 3 – Munitions Removal from Planned Public Areas, Hazard Warning Signs, Educational Kiosks, and Confirmatory Munitions Characterization
  This alternative is nearly identical in terms of footprint to Alternative 2. Due to the extra week of daily local driving, GHG, total NO_x, total SO_x, and total PM_{10} footprints are slightly greater for Alternative 3. The extra week of onsite labor hours also resulted in an increased accident risk injury and fatality footprints. Results are provided in **Table B-5**.

1.4 Uncertainty Assessment

SiteWise™ does not include water consumption, NO_X, SO_X, and PM_{10} footprints for material manufacturing. Therefore, these categories may be underestimated if material use is intensive.

1.5 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.

Additional opportunities to reduce the environmental footprint include the use of a wood fence or sourcing fence material from a locally available recycled source.

1.6 References

Battelle. 2013. *SiteWise™*. NAVFAC Engineering Service Center, UG-2092-ENV. October.

TABLE B-1

Alternative 2 -Munitions Removal from Planned Public Areas, Hazard Warning Signs, and Educational Kiosks

SWMU 4 Engineering Evaluation/Cost Analysis for a Non-Time Critical Removal Action

Former Naval Ammunition Support Detachment

Vieques, Puerto Rico

Sitewise Tab	**Assumptions**
Remedial Action Construction	
Labor Hours Onsite	8 people, 6 months, 10 hours/day, 5 days/week
Materials	Approximately 500 lbs of wood for fence posts and kiosks. Assume very low impact material
Personnel Transportation - Air	3,000 miles per trip, 96 trips per cost estimate
Personnel Transportation - Road	Local Travel - 25 miles per day, 8 people, 4 shared cars, 5 days per week (24 weeks) (heavy duty, diesel)
Material and Equipment Transportation	Approximately 500 lbs of fence posts and kiosks, coming from San Juan, 100 miles road and 50 miles water (one way)
	Road Repair - Dump truck (20 tons), front end loader (20 tons), grader (20 tons), bull dozer (20 tons). 100 miles road and 50 miles water (each way)
Equipment Use	Kiosk/Sign Installation: 1 front end loader, 3 days, 8 hours per day. 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)
	Road Repair
	Grader - 500 CY
	Front End Loader - 500 CY
	Bull Dozer - 500 CY
	Dump truck - 500 CY
Residual handling	48 tons of metal to recycling - 100 miles by land and 50 by water (included in material transportation)

TABLE B-2

Alternative 3 - Munitions Removal from Planned Public Areas, Hazard Warning Signs, Educational Kiosks, and Confirmatory Munitions Characterization

SWMU 4 Engineering Evaluation/Cost Analysis for a Non-Time Critical Removal Action

Former Naval Ammunition Support Detachment

Vieques, Puerto Rico

Sitewise Tab	**Assumptions**
Remedial Action Construction	
Labor Hours Onsite	8 people, 6 months and 1 week, 10 hours/day, 5 days/week
Materials	Approximately 500 lbs of wood for fence posts and kiosks. Assume very low impact material
Personnel Transportation - Air	3,000 miles per trip, 96 trips per cost estimate
Personnel Transportation - Road	Local Travel - 25 miles per day, 8 people, 4 shared cars, 5 days per week (25 weeks) (heavy duty, diesel)
Material and Equipment Transportation	Approximately 500 lbs of fence posts and kiosks, coming from San Juan, 100 miles road and 50 miles water (one way)
	Road Repair - Dump truck (20 tons), front end loader (20 tons), grader (20 tons), bull dozer (20 tons). 100 miles road and 50 miles water (each way)
Equipment Use	Kiosk/Sign Installation: 1 bobcat, 3 days, 8 hours per day. 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)
	Road Repair
	Grader - 500 CY
	Front End Loader - 500 CY
	Bull Dozer - 500 CY
	Dump truck - 500 CY
Residual handling	48 tons of metal to recycling - 100 miles by land and 50 by water (included in material transportation)

TABLE B-3

Relative Impact of Alternatives

SWMU 4 Engineering Evaluation/Cost Analysis for a Non-Time Critical Removal Action

Former Naval Ammunition Support Detachment

Vieques, Puerto Rico

Remedial Alternatives	GHG Emissions	Total energy Used	Water Used	Total NO_x emissions	Total SO_x Emissions	Total PM10 Emissions	Accident Risk Fatality	Accident Risk Injury
	metric ton	MMBTU	gallons	metric ton	metric ton	metric ton		
Alternative 2 - Munitions Removal from Planned Public Areas, Hazard Warning Signs, and Educational Kiosks	82	1093	0	2.00E-01	2.22E-02	3.10E-03	1.11E-03	2.37E-01
Alternative 3 - Munitions Removal from Planned Public Areas, Hazard Warning Signs, Educational Kiosks, and Confirmatory Munitions Characterization	83	1102	0	2.00E-01	2.22E-02	3.12E-03	1.15E-03	2.47E-01

Remedial Alternatives	GHG Emissions	Total energy Used	Water Used	Total NO_x emissions	Total SO_x Emissions	Total PM10 Emissions	Accident Risk Fatality	Accident Risk Injury
Alternative 2 - Munitions Removal from Planned Public Areas, Hazard Warning Signs, and Educational Kiosks	High	High	Low	High	High	High	Low	High
Alternative 3 - Munitions Removal from Planned Public Areas, Hazard Warning Signs, Educational Kiosks, and Confirmatory Munitions Characterization	High	High	Low	High	High	High	Low	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

NOx - Nitrogen Oxides

SOx - Sulfur Oxides

LUCs - land use controls

PM10 - Particulate Matter

GHG - Greenhouse Gases

MEC - munitions and explosives of concern

TABLE B-4

Alternative 2 -Munitions Removal from Planned Public Areas, Hazard Warning Signs, and Educational Kiosks

SWMU 4 Engineering Evaluation/Cost Analysis for a Non-Time Critical Removal Action

Former Naval Ammunition Support Detachment

Vieques, Puerto Rico

Phase	Activities	GHG Emissions	Total Energy Used	Water Used	Total NO_x Emissions	Total SO_x Emissions	Total PM_{10} Emissions	Accident Risk Fatality	Accident Risk Injury
		metric ton	MMBTU	gallons	metric ton	metric ton	metric ton		
Remedial Action Construction	Consumables	0	0	NA	0.0E+00	0.0E+00	0.0E+00	NA	NA
	Transportation-Personnel	78	1039	NA	1.75E-01	1.68E-02	1.54E-03	2.16E-04	1.51E-02
	Transportation-Equipment	3	36	NA	1.52E-02	3.09E-03	4.53E-04	8.58E-06	6.91E-04
	Equipment Use and Misc	1	18	0	9.30E-03	2.35E-03	1.11E-03	8.81E-04	2.21E-01
	Residual Handling	0	0	NA	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total		**82**	**1093**	**0.E+00**	**2.E-01**	**2.E-02**	**3.E-03**	**1.E-03**	**2.E-01**

Notes:

MMBTU - million British Thermal Unit

NOx - Nitrogen Oxides

SOx - Sulfur Oxides

PM10 - Particulate Matter

NA - Not Applicable

GHG - Greenhouse Gases

TABLE B-5

Alternative 3 - Munitions Removal from Planned Public Areas, Hazard Warning Signs, Educational Kiosks, and Confirmatory Munitions Characterization

SWMU 4 Engineering Evaluation/Cost Analysis for a Non-Time Critical Removal Action

Former Naval Ammunition Support Detachment

Vieques, Puerto Rico

Phase	Activities	GHG Emissions	Total Energy Used	Water Used	Total NO_x Emissions	Total SO_x Emissions	Total PM_{10} Emissions	Accident Risk Fatality	Accident Risk Injury
		metric ton	MMBTU	gallons	metric ton	metric ton	metric ton		
Remedial Action Construction	Consumables	0	0	NA	0.0E+00	0.0E+00	0.0E+00	NA	NA
	Transportation-Personnel	79	1048	NA	1.75E-01	1.68E-02	1.56E-03	2.24E-04	1.57E-02
	Transportation-Equipment	3	36	NA	1.52E-02	3.09E-03	4.53E-04	8.58E-06	6.91E-04
	Equipment Use and Misc	1	18	0	9.30E-03	2.35E-03	1.11E-03	9.17E-04	2.31E-01
	Residual Handling	0	0	NA	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total		**83**	**1102**	**0**	**2.00E-01**	**2.22E-02**	**3.12E-03**	**1.15E-03**	**2.47E-01**

Notes:

MMBTU - million British Thermal Unit

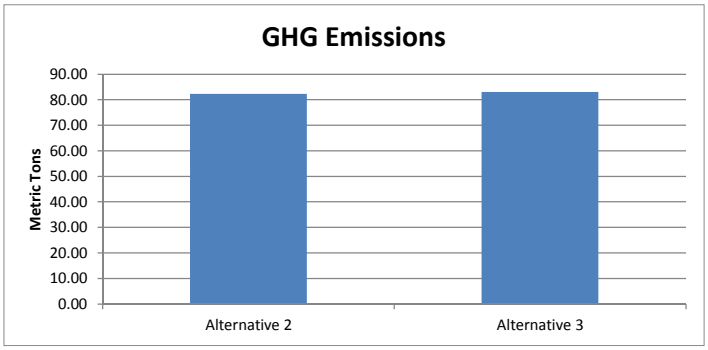
NOx - Nitrogen Oxides

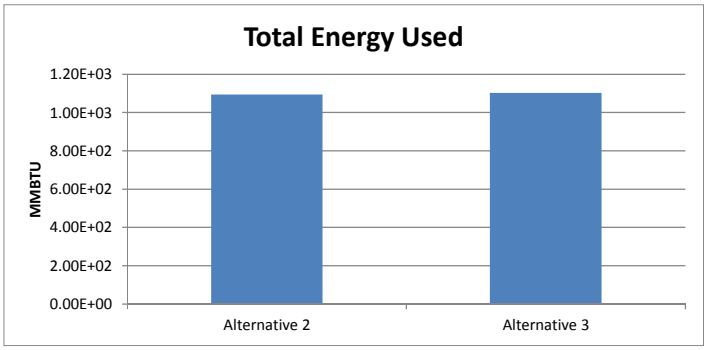
SOx - Sulfur Oxides

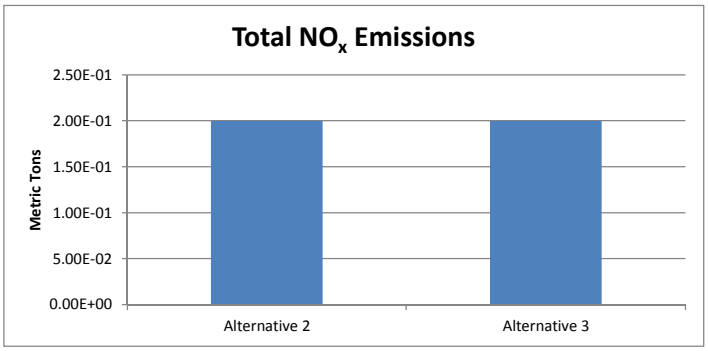
PM10 - Particulate Matter

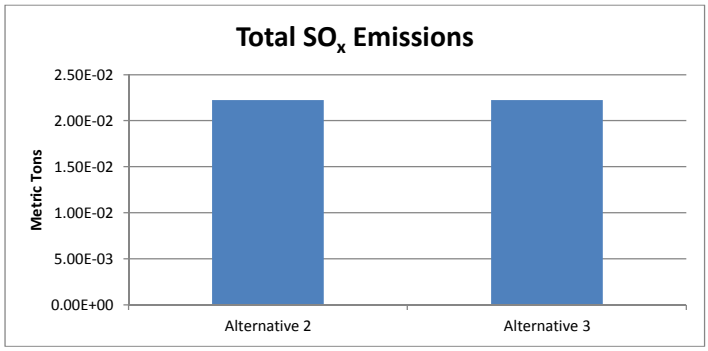
NA - Not Applicable

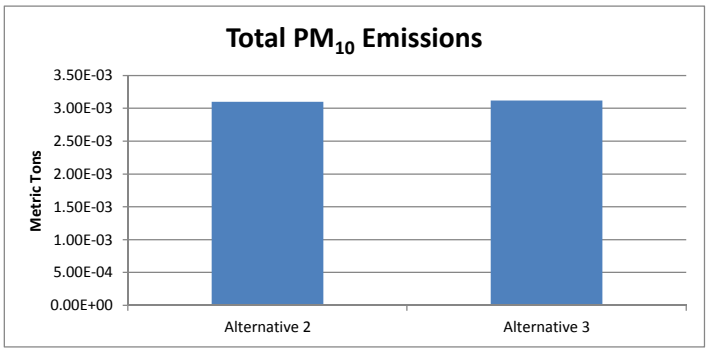
GHG - Greenhouse Gases

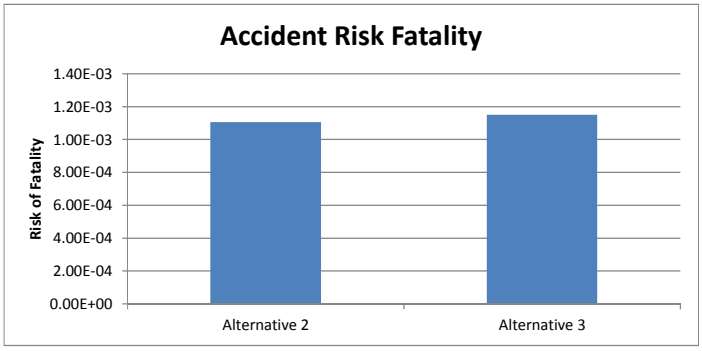












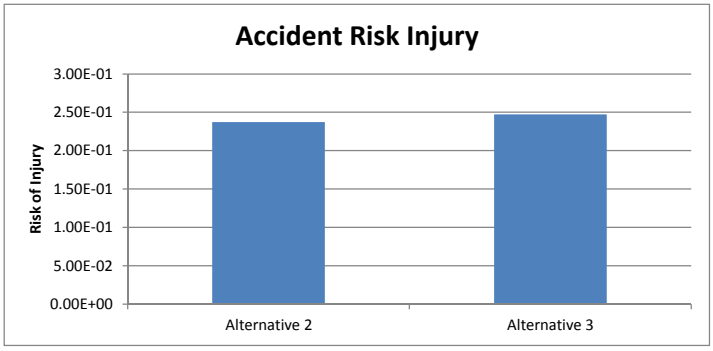


Figure B-1
Summary of Alternatives
SWMU 4 EE/CA
Former Vieques Naval Ammunition Support Detachment
Vieques, Puerto Rico