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FINAL EXPANDED SITE INSPECTION REPORT UNEXPLODED ORDNANCE 16 (UXO 16)  
ADJACENT TO SOLID WASTE MANAGEMENT UNIT 4 (SWMU 4) ATLANTIC FLEET  
WEAPONS TRAINING AREA FORMER NAVAL AMMUNITION SUPPORT DETACHMENT  
VIEQUES ISLAND PUERTO RICO  
07/01/2016  
CH2M HILL INC

Final

# **UXO 16 Adjacent to Solid Waste Management Unit 4 Expanded Site Inspection Report**

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

**Contract Task Order 0019**

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Prepared for

**Department of the Navy  
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# Executive Summary

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This Expanded Site Inspection (ESI) Report presents the data and findings obtained from an underwater investigation for potential munitions and explosives of concern (MEC) and other material potentially presenting an explosive hazard (MPPEH) within UXO 16, located adjacent to Solid Waste Management Unit (SWMU) 4, at the former Naval Ammunition Support Detachment (NASD) in Vieques, Puerto Rico (**Figures ES-1 and ES-2**). SWMU 4 was used for open burn/open detonation (OB/OD) activities that may have resulted in the ejection of MEC and other MPPEH into the offshore water of UXO 16. The ESI was intended to determine if and extent of where a release of this material to UXO 16 adjacent to SWMU 4 has occurred and to determine the appropriate path forward for this portion of UXO 16.

ESI activities were conducted from April 1 to May 18, 2015 and included an underwater visual and instrument-aided survey with subsequent identification of items/anomalies observed/detected on and beneath the seafloor to a depth of approximately one foot. The ESI surveyed 14.6 miles of underwater transects using a combination of munitions response divers to locate, excavate, identify, and properly handle items recovered, and scientific divers to ensure threatened corals and other sensitive species and habitats were avoided.

Of the entire 14.2 acres (14.6 miles of transects) surveyed as part of the ESI, only three discarded military munitions (DMM) and 57 munitions debris (MD) (poses no explosive hazard) were identified (**Figure ES-3**). All of the DMM were photoflash cartridges, which is a pyrotechnic cartridge designed to produce a brief/intense illumination for low altitude nighttime photography. All DMM were located within approximately 50 to 350 feet offshore; the majority of the MD were located in areas offshore closest to the OB/OD areas and the mouth of the ephemeral stream.

The nature and extent of munitions within UXO 16, offshore of SWMU 4, is consistent with what is expected based on the Conceptual Site Model (CSM). The majority of the MEC and MD identified within UXO 16, offshore of SWMU 4, were located immediately offshore, the nearest locations to the OB/OD areas, and the mouth of the ephemeral stream. No munitions were identified further offshore, which is consistent with sediment transport moving northwestward with the direction of the waves rather than from the beach to further offshore. No MEC or MD were identified near the former outlet of Laguna Boca Quebrada; therefore, the potential for transport of munitions from the lagoon into the ocean is likely negligible.

Additionally, the nature of the munitions showed significant signs of corrosion and heavy encrustation, which also suggest that the munitions have not been relatively mobile. Munitions casings primarily composed of aluminum (such as photoflash cartridges, flare base sections, etc.) showed less signs of corrosion as compared to the munitions casings composed primarily of steel and iron (i.e., 20-millimeter [mm] projectiles). Although a higher quantity of munitions (primarily 20-mm projectiles) and munitions-related debris was identified within the terrestrial environment of SWMU 4, the fact that most items found on land were 20-mm projectiles and the corrosive ocean environment are the likely reasons so few items are present offshore of SWMU 4.

The nature and extent of MEC and MD has been sufficiently delineated to satisfy the objectives of a Remedial Investigation (RI). However, since MEC has the potential to release munitions constituents (MC), the Environmental Restoration Program (ERP) Technical Subcommittee determined an RI for MC is necessary. The MC nature and extent information gathered during the RI and the MEC/MD nature and extent information gathered during the ESI will be compiled and evaluated in an RI/Feasibility Study (FS) Report.

# Resumen Ejecutivo

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Este Informe de la Inspección Expandida del Sitio (ESI, por sus siglas en inglés) presenta los datos y los resultados obtenidos de una investigación submarina relacionada a municiones y explosivos de preocupación (MEC por sus siglas en inglés) potenciales y otros materiales que potencialmente pudieran presentar un peligro de explosión (MPPEH por sus siglas en inglés) dentro de UXO 16, que se encuentra adyacente a la Unidad de Manejo de Desperdicios Sólidos (SWMU, por sus siglas en inglés) 4, en el antiguo Destacamento Naval de Apoyo a Municiones (NASD por sus siglas en inglés) en Vieques, Puerto Rico (**Figuras 1 y ES-2**). SWMU 4 se utilizó para actividades de quema abierta/detonación abierta (OB/OD por sus siglas en inglés), las cuales pudieron haber resultado en la expulsión de MEC u otro MPPEH hacia el agua fuera de la costa de UXO 16. El ESI tuvo como objetivo determinar si hubo, y de ser el caso, el alcance de alguna liberación de este material hacia UXO 16 que se encuentra adyacente a SWMU 4, y determinar los siguientes pasos apropiados para esta porción de UXO 16.

Las actividades de la ESI se llevaron a cabo del 1 de abril al 18 de mayo de 2015 e incluyeron una inspección visual y con ayuda de un instrumento debajo el agua con la consecuente identificación de artículos/anomalías observados/detectados sobre y debajo del lecho marino a una profundidad de aproximadamente un pie. La ESI inspeccionó 14.6 miles de transectos bajo el agua usando una combinación de buzos especializados en municiones para localizar, excavar, identificar y manejar adecuadamente los artículos recuperados, y buzos científicos para asegurar que se evite el contacto con los corales en peligro de extinción y hábitats sensitivos.

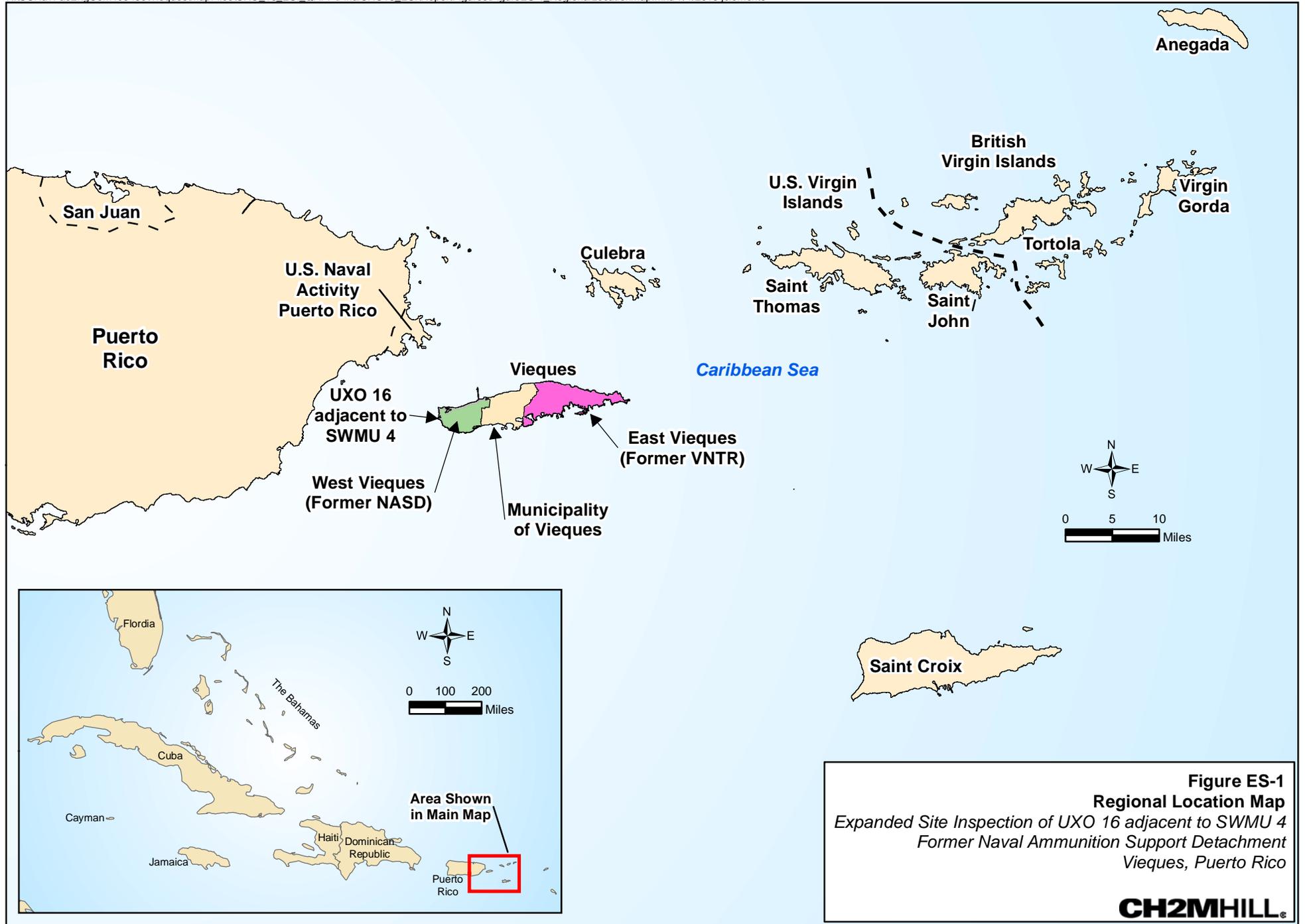
Del total de 14.2 acres (14.6 millas de transectos) estudiados como parte de la ESI, solo se identificaron tres municiones militares descartadas (DMM, por sus siglas in inglés) y 57 escombros de municiones (MD, por sus siglas en inglés) (no presentan ningún riesgo de explosión) (**Figura ES-3**). Todos los DMM fueron cartuchos de luz relámpago, el cual es un cartucho pirotécnico diseñado para producir una breve/intensa iluminación para lograr fotografías a baja altitud durante la noche. Todos los DMM se encontraron dentro de aproximadamente 50 a 350 pies fuera de la costa; la mayoría de los MD se encontraron en áreas fuera de la costa más cercanos a las áreas OB/OD y la desembocadura de la quebrada intermitente.

La naturaleza y el alcance de las municiones dentro de UXO 16 fuera de la costa de SWMU 4, es consistente con lo que se esperaba en base al modelo conceptual del sitio (CSM, por sus siglas en inglés). La mayoría de los MEC y MD identificados dentro de UXO 16 fuera de la costa de SWMU 4, se encuentran inmediatamente fuera de la costa, en los lugares más cercanos a las áreas OB/OD y en la desembocadura de la quebrada. No se encontraron municiones mar afuera, lo cual es consistente con el transporte de sedimentos que se mueve hacia el noroeste siguiendo la dirección de las olas en vez de moverse desde la playa hacia mar afuera. No se identificó MEC o MD cerca de la antigua salida de la Laguna Boca Quebrada; por lo tanto, el potencial de transporte de las municiones de la laguna hacia el océano es probablemente insignificante.

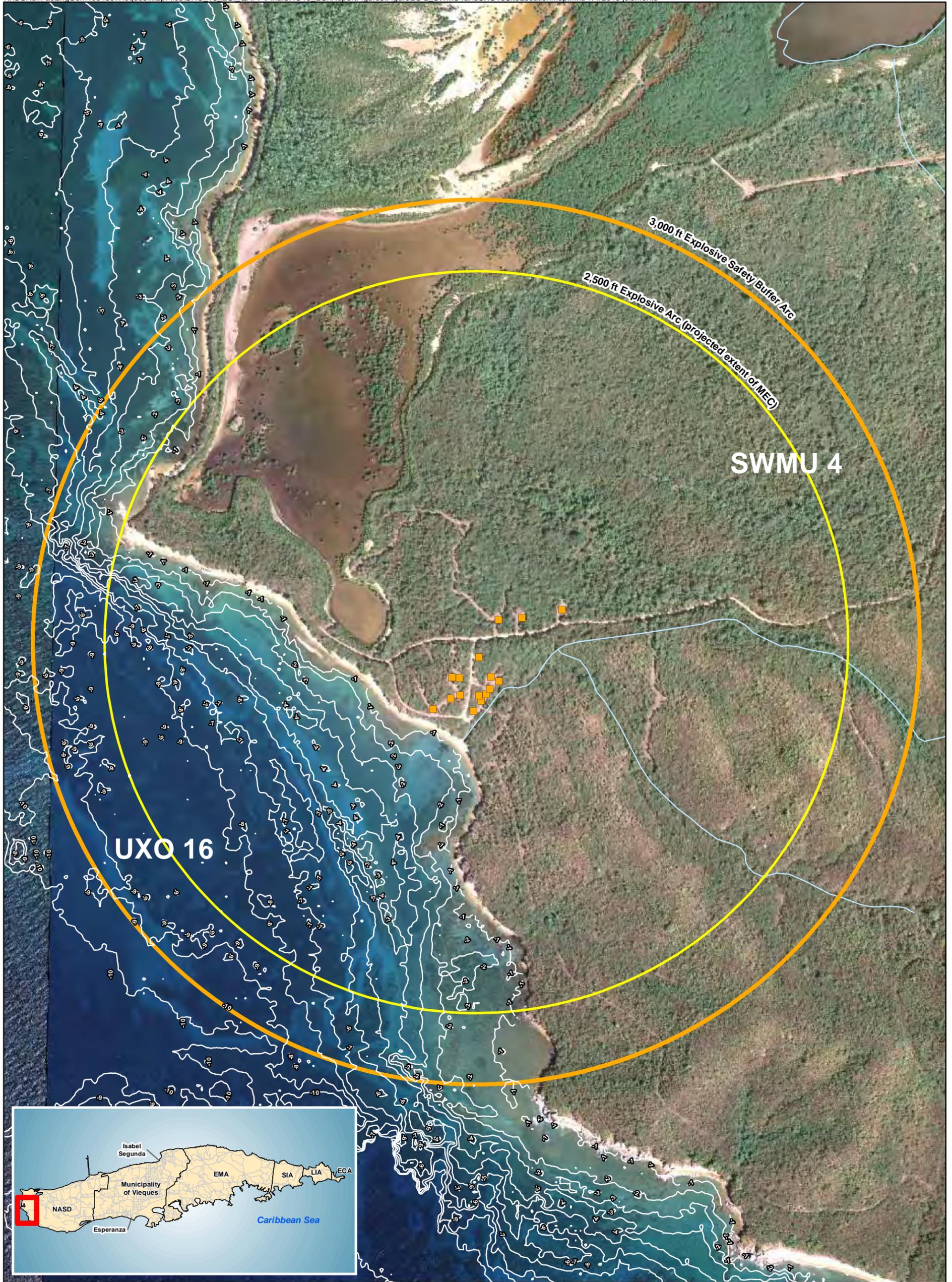
Además, las municiones mostraron rasgos significativos de corrosión e incrustación gruesa, que también sugieren que las municiones relativamente no se han movido mucho. Las cubiertas de las municiones que están compuestas principalmente de aluminio (tal como los cartuchos de luz relámpago, secciones de la base de cohetes de bengalas, etc.) mostraron menos rasgos de corrosión en comparación con las cubiertas de las municiones que se componen principalmente de acero y de hierro (por ejemplo, proyectiles de 20 mm). Aunque una cantidad mayor de municiones (principalmente, proyectiles de 20 mm) y escombros relacionados con municiones se identificaron dentro del ambiente terrestre de SWMU 4; el hecho de que la mayoría de los artículos encontrados en la parte terrestre fueron proyectiles de 20 mm y la naturaleza corrosiva del ambiente marino son las razones probables por las cuales muy pocos artículos están presentes fuera de la costa de SWMU 4.

La naturaleza y el alcance del MEC y MD han sido suficientemente delineados para satisfacer los objetivos de una Investigación para la Remediación (RI, por sus siglas en inglés). Sin embargo, ya que los MEC tienen el potencial de liberar constituyentes de municiones (MC, por sus siglas en inglés), el Subcomité Técnico del Programa de

Restauración Ambiental (ERP, por sus siglas en inglés) determinó que es necesario se lleve a cabo una RI para los constituyentes de municiones. La información sobre la naturaleza y el alcance de los MC que se obtenga durante el RI y la información sobre la naturaleza y la extensión de MEC/MD que se obtuvo durante el ESI será compilada y evaluada en un Informe de RI/Estudio de Viabilidad (FS, por sus siglas en inglés).



**Figure ES-1**  
**Regional Location Map**  
*Expanded Site Inspection of UXO 16 adjacent to SWMU 4*  
*Former Naval Ammunition Support Detachment*  
*Vieques, Puerto Rico*



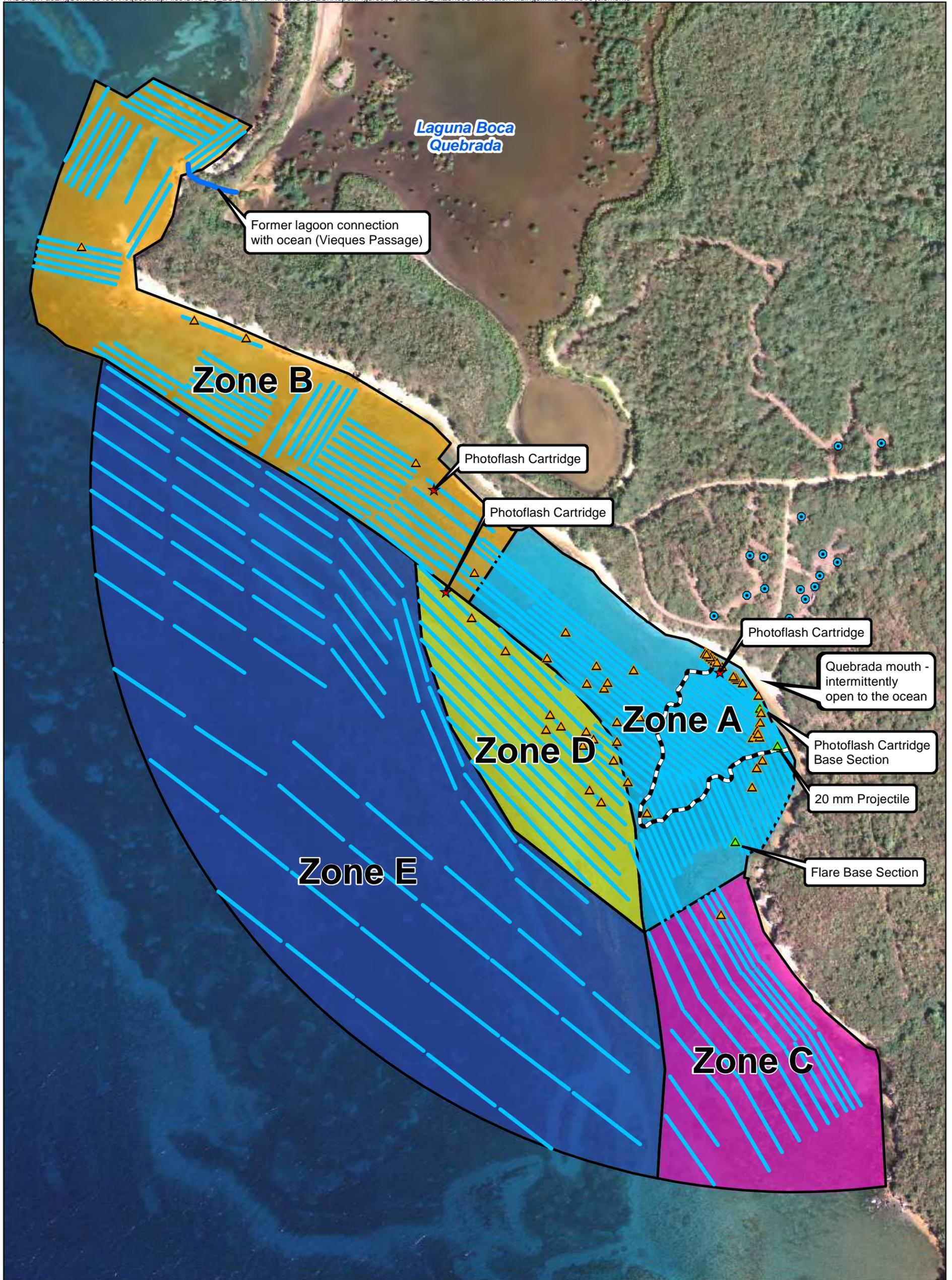
**Legend**

- OB/OD Pits
- Bathymetry Contour (meters)
- Ephemeral Stream



0 500 1,000  
Feet

**Figure ES-2**  
**SWMU 4 and UXO 16 Site Location Map**  
*Expanded Site Inspection of UXO 16 adjacent to SWMU 4*  
*Former Naval Ammunition Support Detachment*  
*Vieques, Puerto Rico*



**Legend**

- OB/OD Areas
- ★ DMM
- ▲ MD
- ▲ MPPEH (2012 Site Inspection)
- General boundary of sand fan associated with quebrada
- Completed survey transect

- Zone A
- Zone B
- Zone C
- Zone D
- Zone E



**Figure ES-3**

**All Zones Underwater Findings**

*Expanded Site Inspection of UXO 16 adjacent to SWMU 4  
Former Naval Ammunition Support Detachment  
Vieques, Puerto Rico*

# Contents

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<b>Executive Summary</b> .....	<b>iii</b>
<b>Resumen Ejecutivo</b> .....	<b>v</b>
<b>Acronyms and Abbreviations</b> .....	<b>ix</b>
<b>1 Introduction</b> .....	<b>1-1</b>
1.1 Objectives and Approach.....	1-1
1.2 Site Background.....	1-1
1.3 Previous Investigations and Interim Actions.....	1-2
1.3.1 SWMU 4.....	1-2
1.3.2 UXO 16.....	1-2
<b>2 Conceptual Site Model</b> .....	<b>2-1</b>
2.1 Source and Release Mechanisms.....	2-1
2.2 Physical Characteristics and Transport Mechanisms.....	2-1
2.3 Potential Receptors.....	2-2
<b>3 Summary of Field Activities</b> .....	<b>3-1</b>
3.1 Investigation Approach.....	3-1
3.1.1 Zone Coverage.....	3-1
3.1.2 Location of Transects.....	3-2
3.2 Field Methodology.....	3-3
3.2.1 Survey Transect Establishment.....	3-3
3.2.2 Biological Resource Avoidance.....	3-3
3.2.3 Anomaly Locating, Excavation, and Identification.....	3-4
3.2.4 Disposition.....	3-5
3.2.5 Exclusion Zone Monitoring.....	3-5
<b>4 Summary of Findings and Path Forward</b> .....	<b>4-1</b>
4.1 Results of Surveys.....	4-1
4.1.1 Site Inspection.....	4-1
4.1.2 Expanded Site Inspection.....	4-1
4.2 Nature and Extent.....	4-2
4.3 Path Forward.....	4-2
<b>5 References</b> .....	<b>5-1</b>

## Appendixes

A	Investigation Photographic Log
B	Munitions Related Items Photographic Log
C	Responses to Regulatory Comments

## Tables

3-1	Survey Area Coverage Results
4-1	Summary of SI/ESI Findings
4-2	Summary of Items Recovered

## Figures

- ES-1 Regional Location Map
- ES-2 SWMU 4 and UXO 16 Site Location Map
- ES-3 All Zones Underwater Findings
  
- 1-1 Regional Location Map
- 1-2 SWMU 4 and UXO 16 Site Location Map
- 1-3 UXO 16 Area Adjacent to SWMU 4 Initial SI Results
  
- 2-1 Conceptual Site Model
- 2-2 SWMU 4 Underwater Habitat Map
- 2-3 SWMU 4 Habitat Photographs
- 2-4 SWMU 4 Wave Direction and Height
- 2-5 Beach Profile Offshore of SWMU 4
  
- 3-1 Underwater Survey Coverage
- 3-2 Underwater Survey Transects
- 3-3 All Zones Below Contract Depth Detections
  
- 4-1 All Zones Underwater Findings
- 4-2 Zone A Underwater Findings
- 4-3 Zone B Underwater Findings
- 4-4 Zone C Underwater Findings
- 4-5 Zone D Underwater Findings
- 4-6 Zone E Underwater Findings

# Acronyms and Abbreviations

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BCD	below contract depth
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CLEAN	Comprehensive Long-term Environmental Action—Navy
CSM	Conceptual Site Model
DGM	digital geophysical mapping
DMM	discarded military munitions
ECA	equipment checkout area
EOD	explosive ordnance disposal
EPA	Environmental Protection Agency
ERP	Environmental Restoration Program
ESI	Expanded Site Inspection
FS	Feasibility Study
GPS	global positioning system
IVS	instrument verification strip
MC	munitions constituent
MD	munitions debris
MEC	munitions and explosives of concern
mm	millimeter
MPPEH	material potentially presenting an explosive hazard
MRS	Munitions Response Site
NASD	Naval Ammunition Support Detachment
NAVFAC	Naval Facilities Engineering Command
Navy	Department of the Navy
NMRD	non-munitions related debris
NTCRA	Non-Time-Critical Removal Action
OB/OD	open burn/open detonation
PRDNER	Puerto Rico Department of Natural and Environmental Resources
PREQB	Puerto Rico Environmental Quality Board
QAPP	Quality Assurance Project Plan
QC	quality control
RI	Remedial Investigation
SI	Site Inspection
SOP	Standard Operating Procedure
SUXOS	Senior UXO Supervisor
SWMU	Solid Waste Management Unit
USAE	USA Environmental, Inc.
USFWS	United States Fish and Wildlife Service
UXO	unexploded ordnance
VNTR	Vieques Naval Training Range
VSP	Visual Sample Plan

# Introduction

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This ESI Report presents the data and findings obtained from an underwater investigation for potential MEC and other MPPEH within UXO 16, located adjacent to SWMU 4, at the former NASD in Vieques, Puerto Rico (**Figures 1-1 and 1-2**). SWMU 4 was used for OB/OD activities that may have resulted in the ejection of MEC and other MPPEH into the offshore water of UXO 16. The ESI was intended to determine if and extent of where a release of this material to UXO 16 adjacent to SWMU 4 has occurred and to determine the appropriate path forward for this portion of UXO 16.

This report was prepared under the Department of the Navy (Navy) Comprehensive Long-term Environmental Action—Navy (CLEAN) Contract for submittal to the Naval Facilities Engineering Command (NAVFAC) Atlantic, United States Environmental Protection Agency (EPA) Region 2, the Commonwealth of Puerto Rico Environmental Quality Board (PREQB), the Commonwealth of Puerto Rico Department of Natural and Environmental Resources (PRDNER), and the United States Fish and Wildlife Service (USFWS). The Navy, EPA, PREQB, PRDNER, and USFWS work jointly as the Vieques ERP Technical Subcommittee.

ESI activities were conducted from April 1 to May 18, 2015 and included an underwater visual and instrument-aided survey with subsequent identification of items/anomalies observed/detected on and beneath the seafloor to a depth of approximately one foot. The ESI surveyed 14.6 miles of underwater transects using a combination of munitions response divers to locate, excavate, identify, and properly handle items recovered, and scientific divers to ensure threatened corals and other sensitive species and habitats were avoided.

ESI activities were conducted in accordance with the following documents:

- *Quality Assurance Project Plan (QAPP), Expanded Site Inspection of UXO 16 Adjacent to Solid Waste Management Unit 4* (CH2M, 2014b).
- *Explosives Safety Submission for Underwater Areas at the Former Naval Ammunition Support Detachment and the Former Anchorage Areas* (CH2M, 2014e).

## 1.1 Objectives and Approach

The objectives of the ESI were to:

- Determine if/where a release of hazardous material (i.e., MEC/other MPPEH) from past Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) related activities occurred.
- Determine whether the suspected release, if confirmed, warrants further investigation or action in accordance with the planned and/or likely land use.

The ESI activities, as defined in the QAPP, comprised the following activities across nearly 200 acres within UXO 16, offshore of SWMU 4:

- Visual inspection by scientific divers to identify and implement avoidance measures where threatened corals, species, and habitats were identified.
- Underwater visual survey for potential MEC/other MPPEH on the seafloor, and an instrument-aided survey and excavation of subsurface anomalies using munitions response divers along survey transects.
- Identification and disposition of MEC/other MPPEH recovered.
- Full-time security boat to maintain exclusion zones from recreational boaters and swimmers.

## 1.2 Site Background

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. The OB/OD operations were conducted in 16 earthen areas where fuels, propellants, and explosives waste material were burned and/or detonated (**Figure 1-2**). These OB/OD activities likely resulted in ejection of MEC/other MPPEH and related debris to the terrestrial and offshore environments; additionally, MEC/other MPPEH and related debris may have been transported overland to the offshore area via surface runoff.

UXO 16 is approximately 11,500 acres within the Caribbean Sea and Vieques Sound comprising the offshore portions of Vieques including former ship anchor points and the area immediately surrounding Mosquito Pier where munitions may have been transferred; areas where munitions may have been inadvertently fired into the water from Naval gunfire training, air-to-ground bombing, and artillery and training ranges; and areas where OB/OD activities may have ejected munitions into the water. The offshore area adjacent to SWMU 4 is part of UXO 16; this area is approximately 200 acres in size, generally defined by the explosive safety arc and projected extent of MEC/other MPPEH (**Figure 1-2**).

## 1.3 Previous Investigations and Interim Actions

This subsection briefly summarizes previous investigations and interim actions conducted at SWMU 4 that are relevant to the portion of UXO 16 adjacent to SWMU 4, and a Site Inspection (SI) previously conducted within UXO 16 adjacent to SWMU 4. Detailed historical information regarding SWMU 4 can be found in the Remedial Investigation/Feasibility Study (RI/FS) Report (CH2M, 2012a). SWMU 4 has been investigated for both MEC/other MPPEH and for potential chemical contaminants and interim actions to remove MEC/other MPPEH have been conducted. Since the UXO 16 ESI focused on the occurrence and extent of MEC/other MPPEH, the results of SWMU 4 MEC/other MPPEH investigations and interim actions are summarized below.

### 1.3.1 SWMU 4

Several investigations and interim actions have been conducted at SWMU 4. The SWMU 4 RI was conducted in three phases from January 2002 through July 2003 to characterize the nature and extent of MEC and assess potential explosive hazards (CH2M, 2012a). In addition, a Non-Time-Critical Removal Action (NTCRA) was conducted in 2009 across approximately 24 acres of SWMU 4 roadways and beaches (CH2M, 2012b), and another NTCRA was initiated in January 2015 across an additional 45 acres to reduce the explosive hazard in areas identified by USFWS for future public use (CH2M, 2014d).

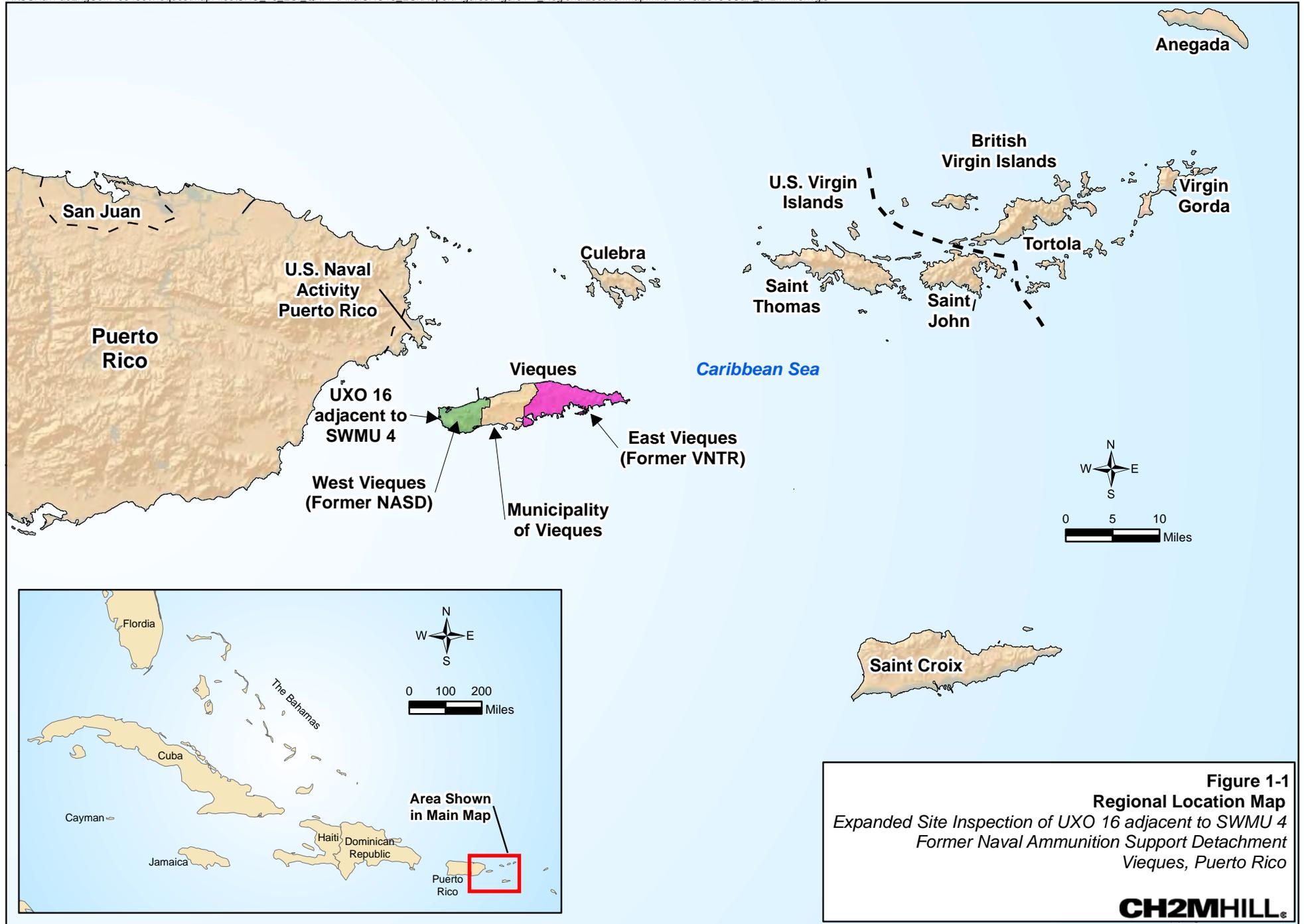
Based on the results of the RI and interim actions, over 90 percent of the MEC/other MPPEH recovered at SWMU 4 were 20-mm projectiles. MEC/other MPPEH classified as greater than 30-mm were generally found within a 1,000-foot radius of the OB/OD areas; however, less than eight percent of the MEC/other MPPEH recovered were larger than 30-mm. No MEC/other MPPEH has been found beyond the 2,500-foot arc (CH2M, 2012b).

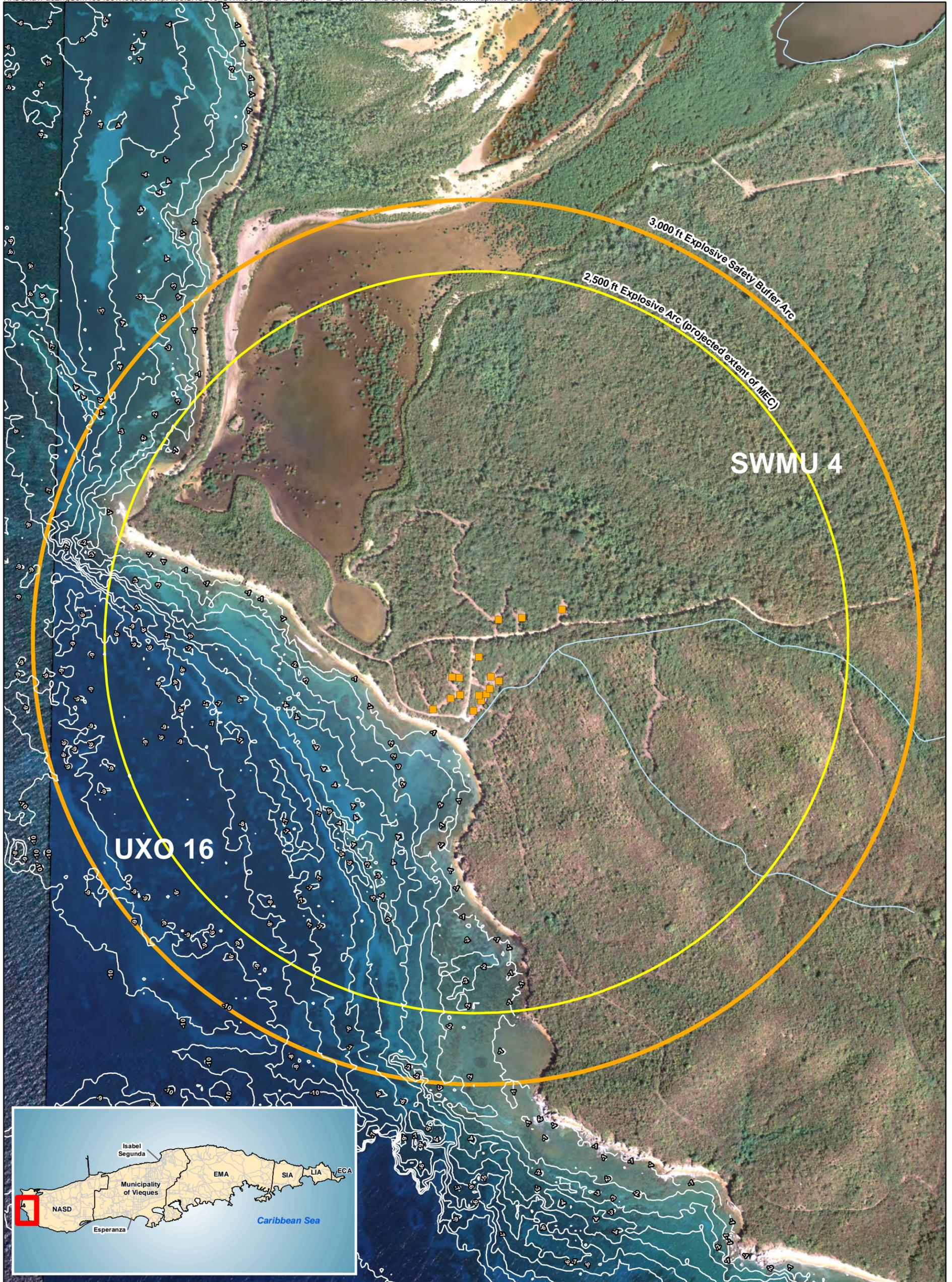
### 1.3.2 UXO 16

SI field activities were conducted at UXO 16, offshore of SWMU 4, from July 9 to 15, 2012, within 14 acres of the 200-acre area shown in **Figure 1-3**. The SI was not intended as a full-scale study of the nature and extent of contamination or explosives hazards, rather it was conducted to assess whether or not there was a potential presence of MEC/other MPPEH in a relatively focused area. SI field activities were conducted by USA Environmental, Inc. (USA E), with biological oversight support from CH2M HILL.

The underwater investigation included diver surveys (visual and magnetometer-aided) along transects focused in the near-shore area closest to the OB/OD areas and the confluence of the ephemeral stream with the beach. Fourteen transects were surveyed, each spaced approximately 50 feet apart and extending from 600 to 800 feet from the shore. Three other MPPEH were identified, including a 20-mm projectile, an expended M123 series photoflash cartridge base section, and a 40-mm flare base section, all of which were removed. In addition, 72 metallic anomalies (non-MEC/other MPPEH) were detected. The results of the SI are included in the summary of findings discussion in Section 4.

Biological oversight was conducted during the SI to prevent diver survey activities from damaging sensitive or protected habitats or species. In addition, a qualitative survey of the marine habitat types was conducted throughout the underwater area of UXO 16 adjacent to SWMU 4, the results of which are discussed in Section 2.



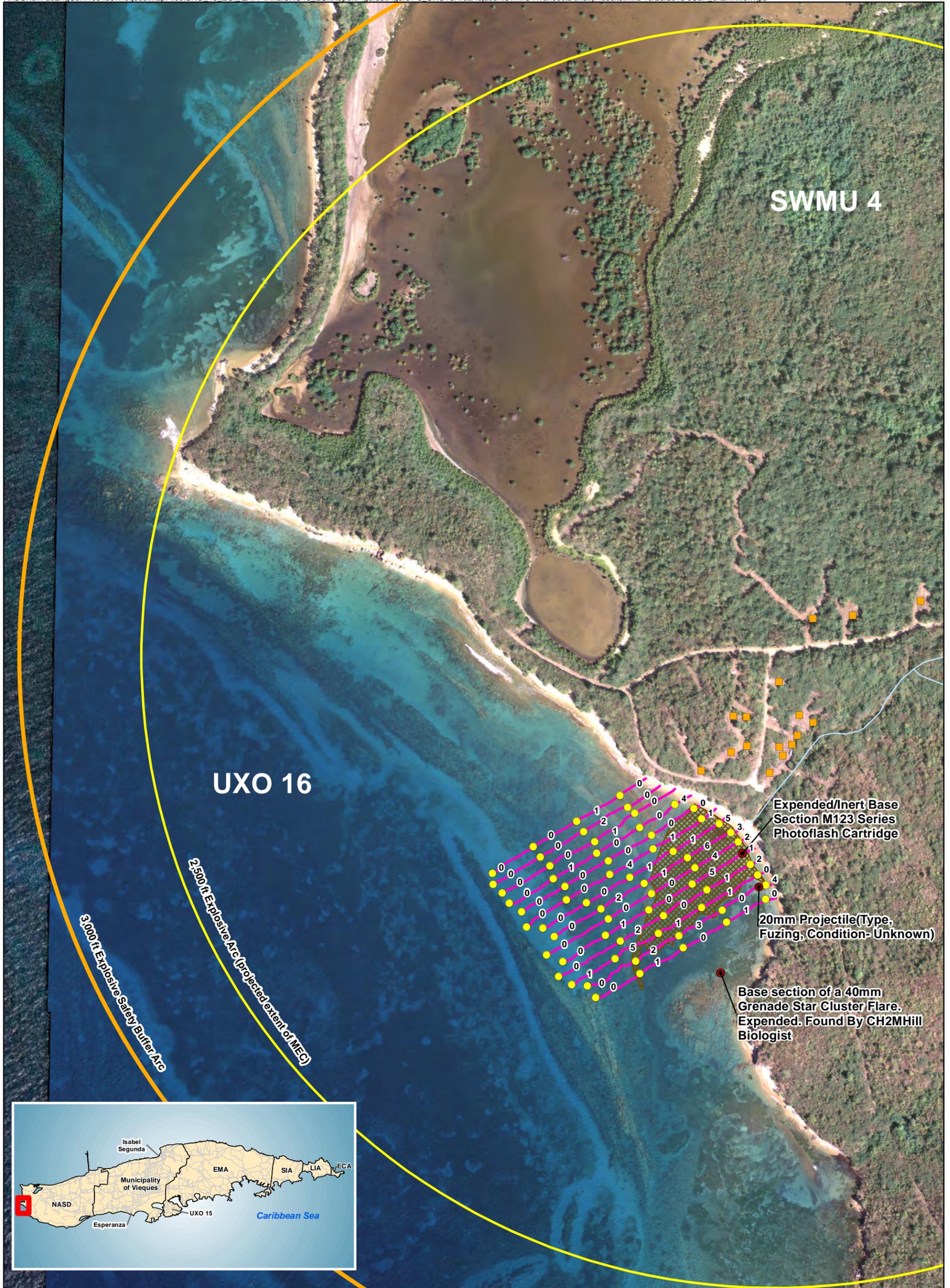


**Legend**

- OB/OD Pits
- Bathymetry Contour (meters)
- Ephemerical Stream



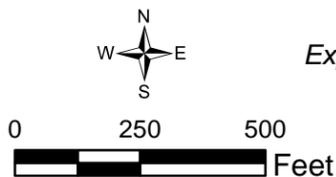
**Figure 1-2**  
**SWMU 4 and UXO 16 Site Location Map**  
 Expanded Site Inspection of UXO 16 adjacent to SWMU 4  
 Former Naval Ammunition Support Detachment  
 Vieques, Puerto Rico



**Legend**

- Interval Point (200ft Intervals)
- Underwater Transects from July, 2012 Site Inspection
- MPPEH Location
- Ephemeral Stream
- OB/OD Areas
- Delta from Ephemeral Stream

Note:  
- Spacing for Transects is Approximately 50 ft.



**Figure 1-3**  
**UXO 16 Area Adjacent to SWMU 4 Initial SI Results**  
*Expanded Site Inspection of UXO 16 adjacent to SWMU 4  
Former Naval Ammunition Support Detachment  
Vieques, Puerto Rico*

# Conceptual Site Model

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The CSM for UXO 16 is shown in **Figure 2-1** and described below. The CSM is based on historical information regarding SWMU 4, including investigations and interim actions, and the results of the UXO 16 SI and ESI and addresses both munitions and potential chemical contamination from munitions and munitions-related items. However, the ESI was intended to identify only the presence of munitions and not designed to identify potential chemical contamination (munitions constituents), which will be considered as part of the RI. Therefore, the CSM discussion below focuses primarily on physical MEC/other MPPEH.

## 2.1 Source and Release Mechanisms

The sources of MEC/other MPPEH within UXO 16 are the disposal activities that took place within the OB/OD areas. The primary release mechanism from the OB/OD areas to UXO 16 would have been ejection of MEC/other MPPEH and related debris directly into the water. In addition MEC/other MPPEH and related debris may have been transported to the offshore environment via overland transport. Further, Laguna Boca Quebrada was formerly connected to the Vieques Sound, which may have provided a route of potential MEC/other MPPEH transport from the lagoon to UXO 16.

## 2.2 Physical Characteristics and Transport Mechanisms

A wide range of seafloor conditions and habitat types occur within UXO 16 adjacent to SWMU 4 including, in order of highest to lowest percent cover, seagrass, coral reef and colonized pavement (low relief solid carbonate rock), sand colonized with macroalgae, coral reef and colonized bedrock (exposed bedrock contiguous with the shoreline), and bare sand (**Figure 2-2**). Photographs of some of the seafloor conditions and habitats are shown in **Figure 2-3**. The greatest density and diversity of hard and soft coral occurs within the coral reef and colonized pavement habitat in the northern half of the UXO 16 area. At the mouth of the ephemeral stream, a sand delta extends offshore and bare sand occurs in this area.

Munitions-related items offshore of SWMU 4 may move due to the effects of waves (which predominantly move south to north adjacent to SWMU 4). The wave climate in Vieques is typically with predominant easterly Trade Winds. As these waves travel to shallow water and approach SWMU 4, the direction of the waves is modified by refraction due to the bathymetry and diffraction from headlands, as shown in **Figure 2-4** (CariCOOS). MEC/other MPPEH is more mobile where there is a sandy bottom and the depth is shallow enough for wave action to mobilize sediment (and thereby MEC/other MPPEH).

Beyond the depth of closure (depth beyond which wave action would not affect sediment transport), waves would not affect munitions-related item movement except under extreme conditions. This depth is approximately 10 to 12 feet adjacent to SWMU 4 (refer to **Figure 3-1** for the approximate location of the depth of closure adjacent to SWMU 4). The depth of closure within UXO 16, adjacent to SWMU 4, was estimated using a formula by Hallermeier (1981) with estimates from wave measurements from a comparable locale (St. Thomas) and wave transformation coefficients derived from observations during a site visit.

In addition, monthly wave observations have been performed from May to September 2015 as part of an ongoing beach dynamics investigation being conducted separately (CH2M, 2014a). The wave climate offshore of SWMU 4 was observed during this period to be benign and conducive to only weak or limited sediment transport. Waves were approximately 0.5 meters (1.5 feet) high from the south (with a five second wave period) and were reduced to approximately 0.2 meters (0.7 feet) as the waves break on the beach, as shown in **Figure 2-4**.

In addition, at the same time the wave observations were made, beach profiles were measured along transects offshore of SWMU 4. The beach profile for the transect adjacent to the OB/OD areas and where the higher densities of MD were observed is shown in **Figure 2-5**. Based on five months of observations, the beach profile has been consistent month to month, which suggests that sediment transport is minimal due to the benign wave

climate offshore of SWMU 4. However, under extreme conditions like hurricanes, sediment transport can be more substantial and extend beyond the depth of closure.

In addition to being transported, MEC/other MPPEH may also be buried within sediment beneath the seafloor. The amount of burial is dependent on the wave conditions and size of the munitions. The oscillatory flow induced by the waves near the seafloor bottom may be modified by objects, such as by MEC/MPPEH. This flow-object interaction generates eddies, increased flow velocities, and increased localized shear stresses that scour the bottom and create depressions around the object, into which the object rolls and starts to become buried. This burial by rolling process continues until the object buries to a depth similar to or slightly greater than its diameter. Under extreme conditions like hurricanes, MEC/other MPPEH burial can be deeper and items are likely transported toward the beach.

MEC/other MPPEH can substantially or completely degrade in seawater. Corrosion of metal munitions casings within the underwater environment can be significant and is affected by wall thickness, metal type (i.e., steel versus aluminum), and potential electrolysis of dissimilar metal components of munitions. Currents of the overlying water can significantly increase corrosion of surface munitions, while for buried munitions deterioration is affected by the munitions casing, depth of burial in sediment, sediment type, and oxidation-reduction conditions (Craig et al., 2011).

## 2.3 Potential Receptors

The potential receptors exposed to MEC/other MPPEH (i.e., explosive hazard) at UXO 16 comprise human receptors such as recreational users (beach users, divers/snorkelers, and fishermen) and researchers. These receptors are more likely to encounter the seafloor when wading, walking, or resting. The deeper areas (further from the shoreline) of UXO 16 would have a significantly smaller percentage of human receptors and MEC/other MPPEH; therefore, exposure would be much less likely.

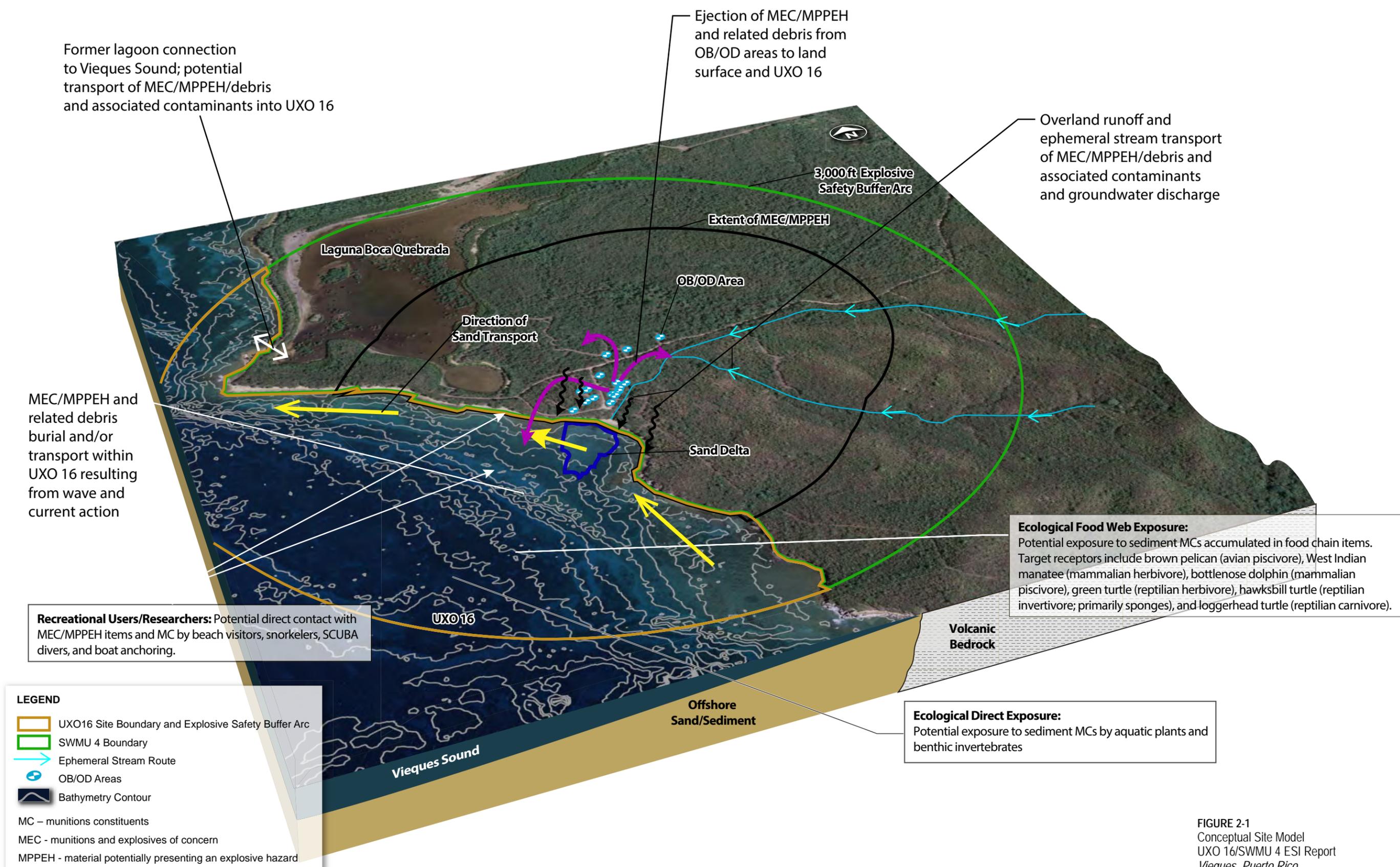
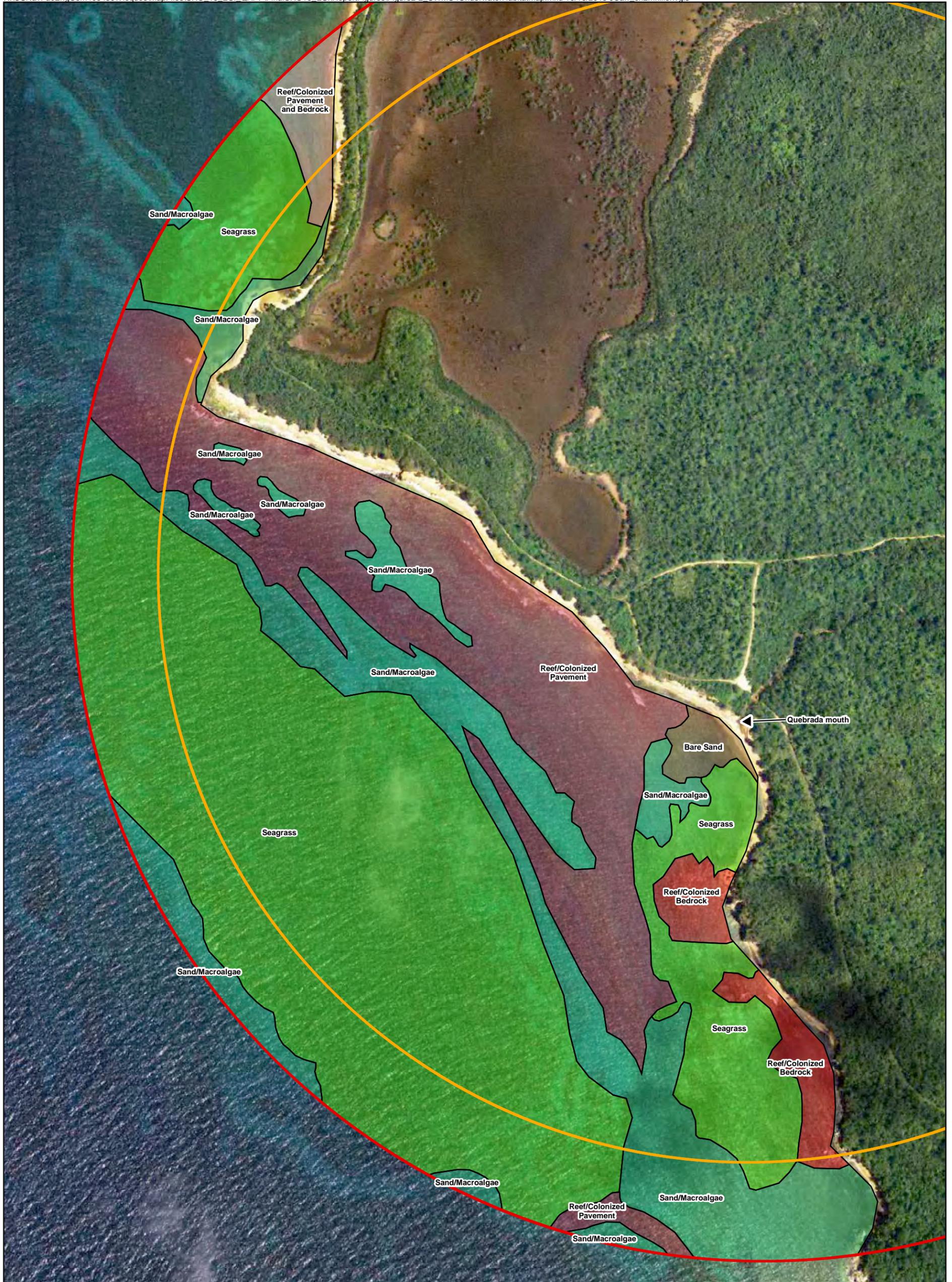


FIGURE 2-1  
Conceptual Site Model  
UXO 16/SWMU 4 ESI Report  
Vieques, Puerto Rico



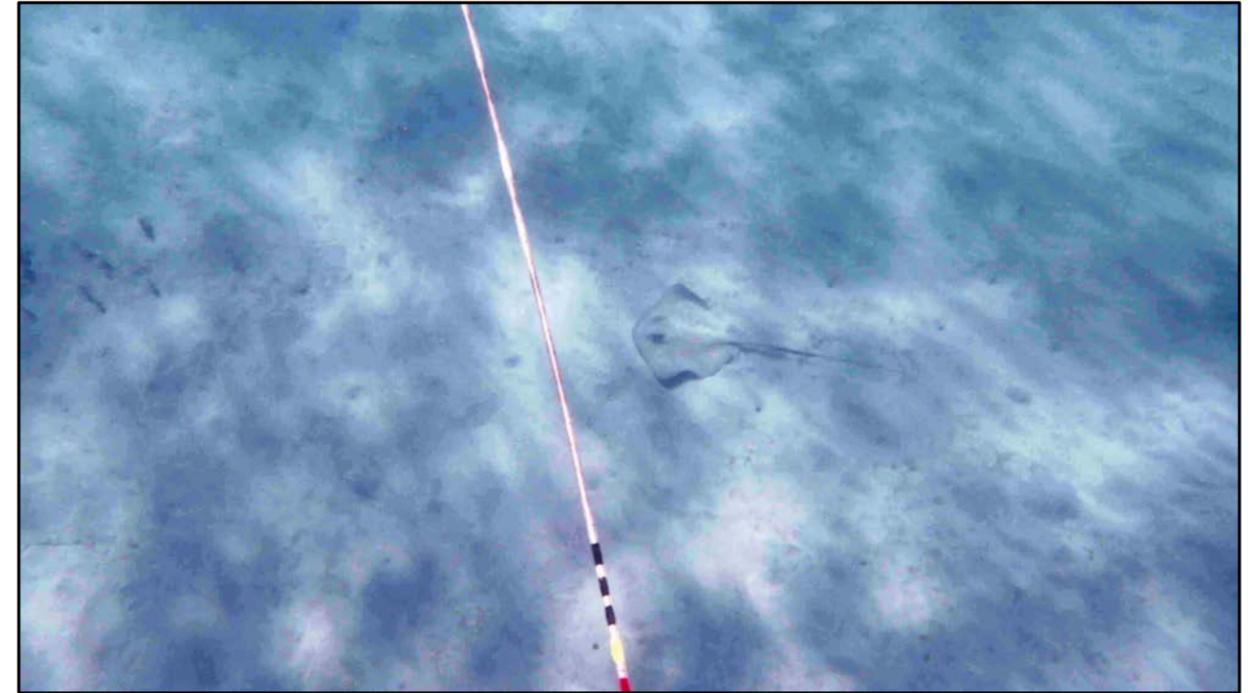
- Legend**
- Projected Extent of MEC
  - SWMU 4 Site Boundary
- Underwater Habitats**
- Bare Sand
  - Reef/Colonized Bedrock
  - Reef/Colonized Pavement
  - Reef/Colonized Pavement and Bedrock
  - Sand/Macroalgae
  - Seagrass



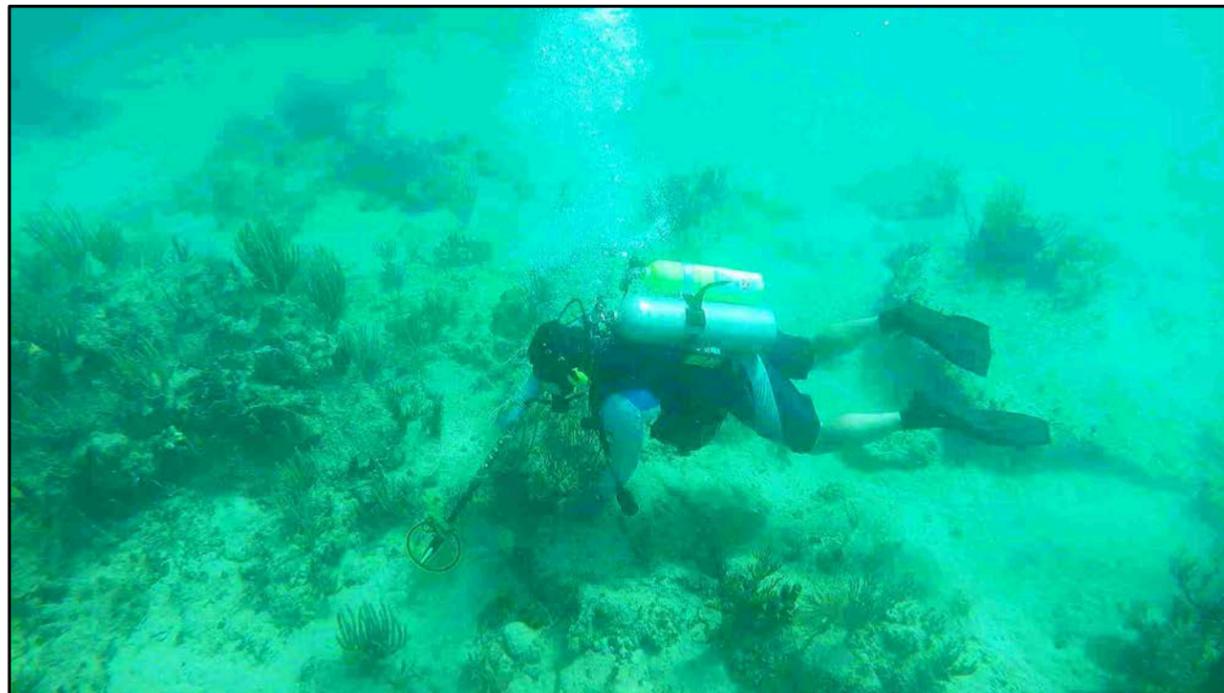
**Figure 2-2**  
**SWMU 4 Underwater Habitat Map**  
 Expanded Site Inspection of UXO 16 adjacent to SWMU 4  
 Former NASD  
 Vieques, Puerto Rico



*Coral Reef Habitat*



*Sand Bottom Habitat*

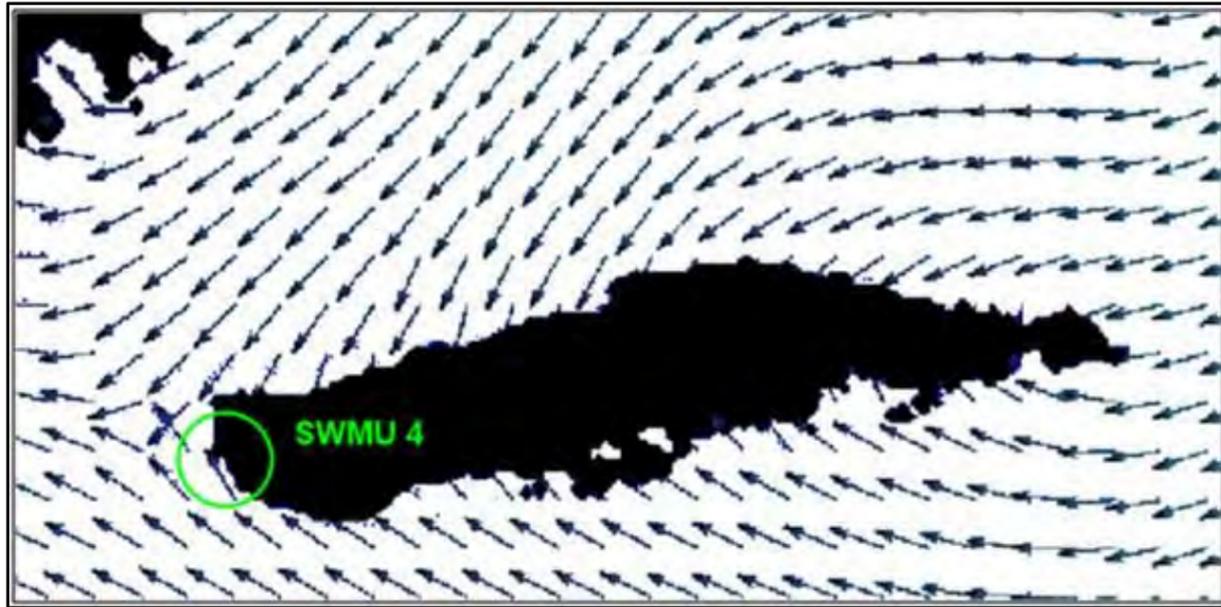


*Patch Reef Habitat*

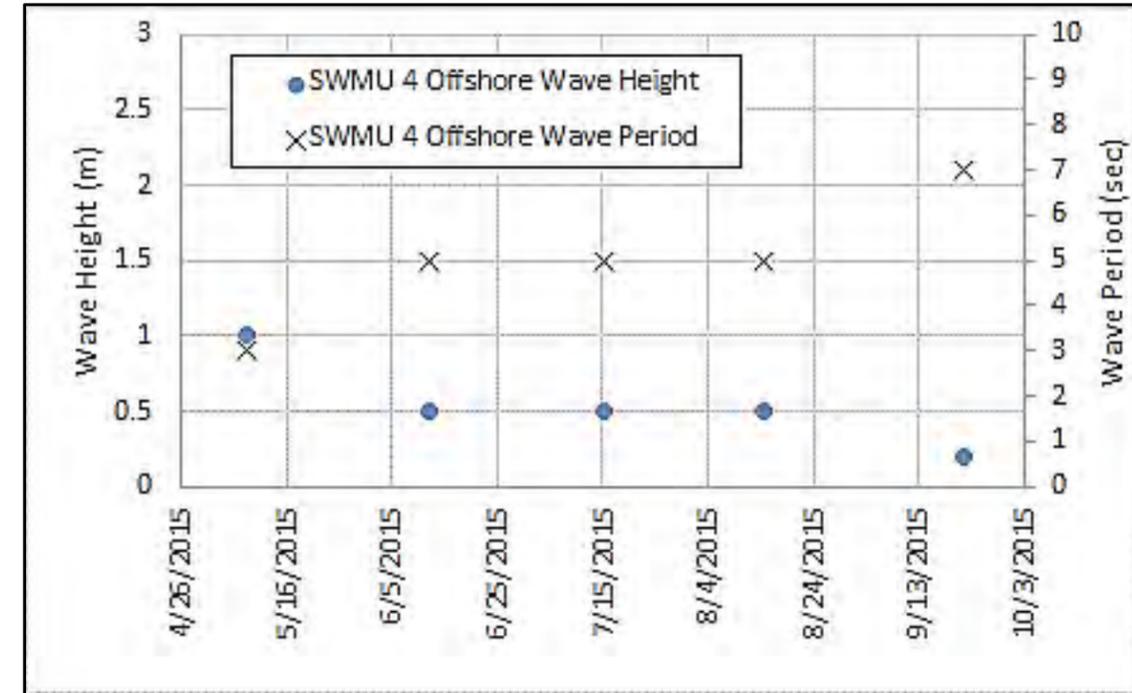


*Seagrass Habitat*

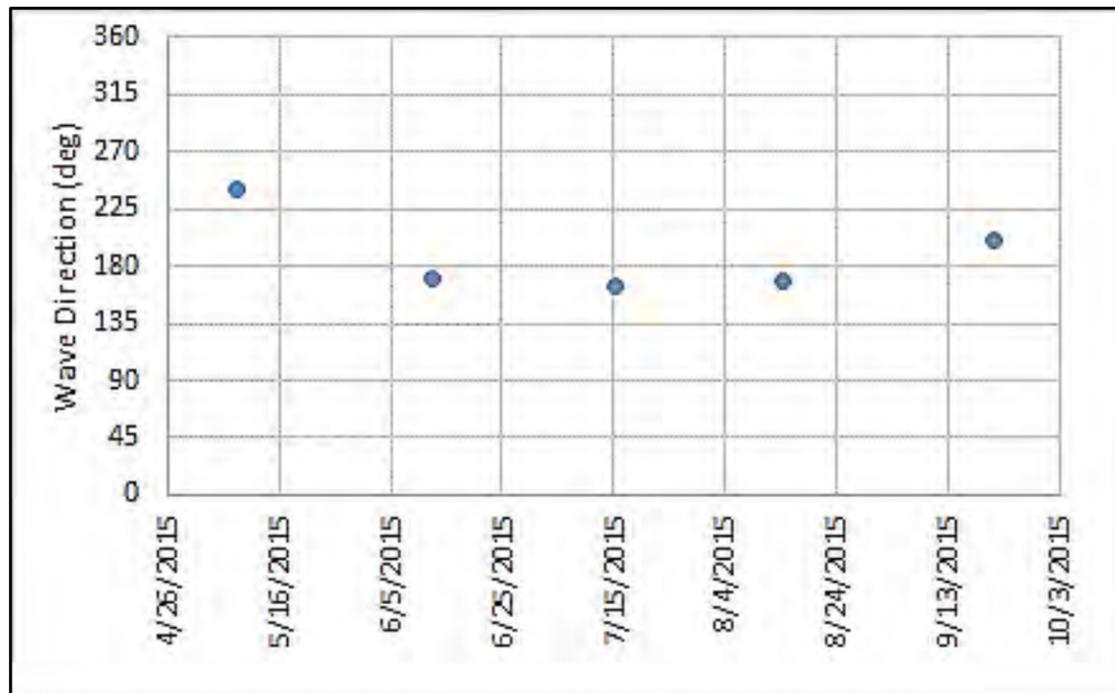
**Figure 2-3**  
**SWMU 4 Habitat Photographs**  
*Expanded Site Inspection of UXO 16 adjacent to SWMU 4*  
*Former Naval Ammunition Support Detachment*  
*Vieques, Puerto Rico*



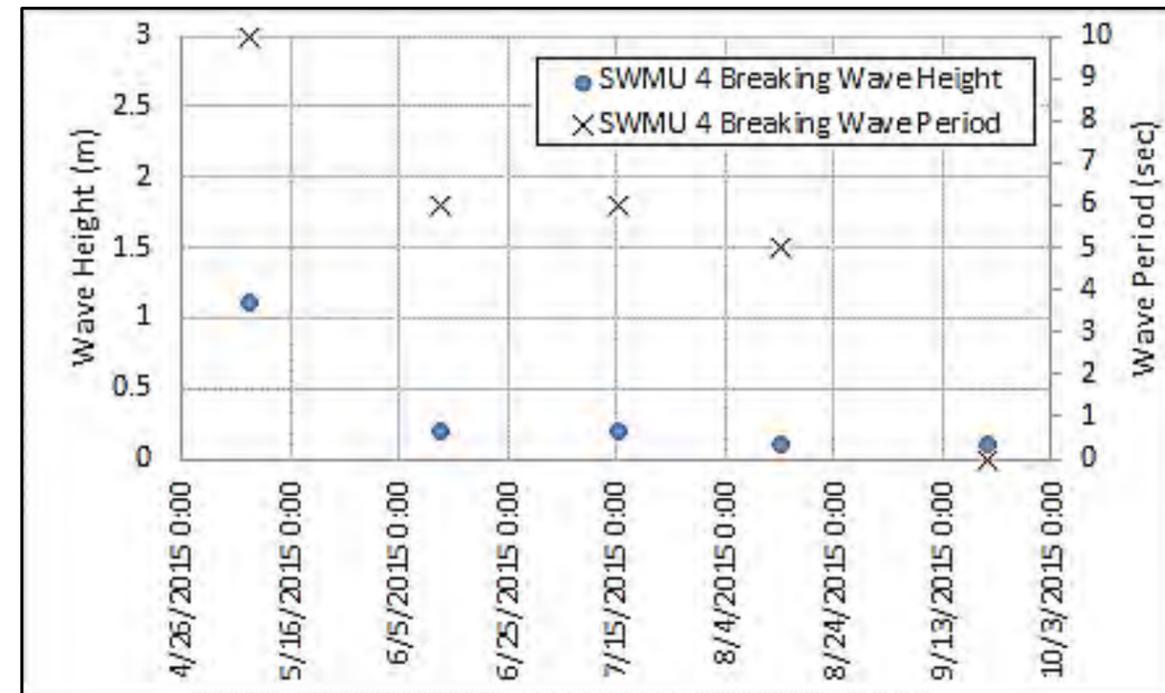
General wave direction off Vieques



Wave heights and periods offshore of SWMU 4



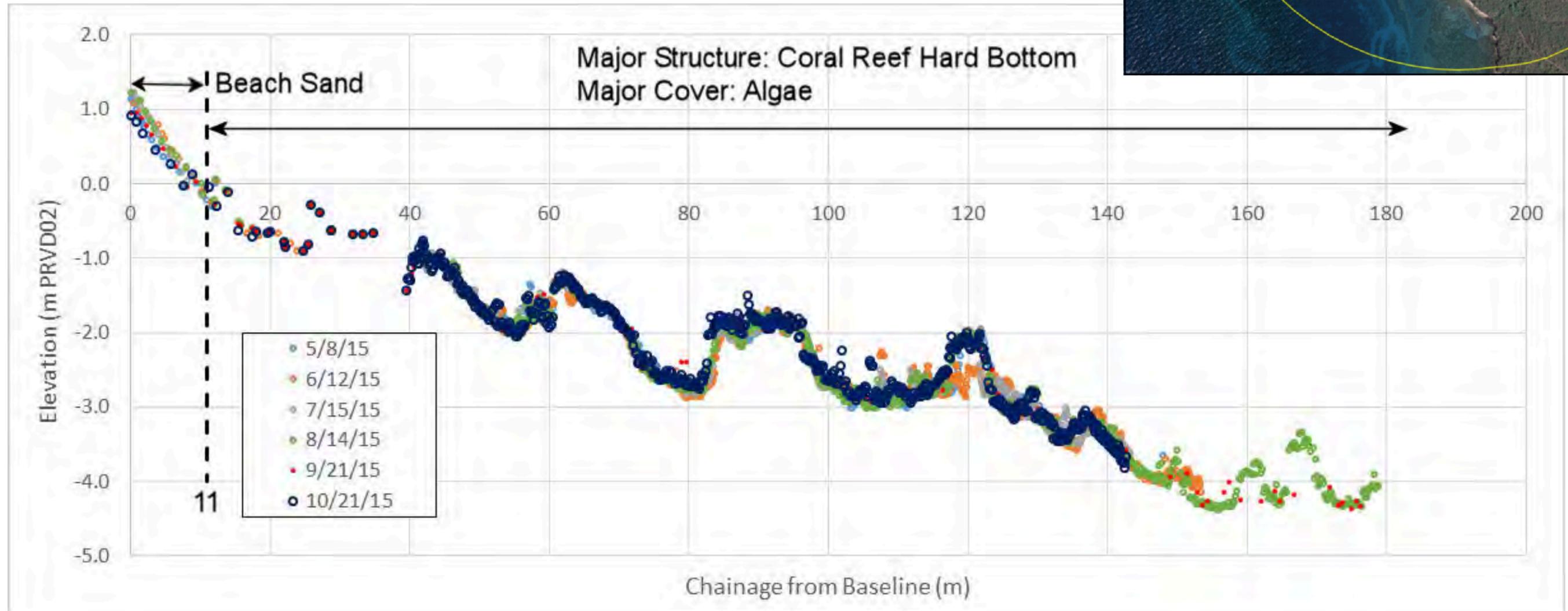
Wave directions offshore of SWMU 4



Heights and periods of waves breaking on the beach offshore of SWMU 4

Figure 2-4  
SWMU 4 Wave Direction and Height  
Expanded Site Inspection of UXO 16 adjacent to SWMU 4  
Former Naval Ammunition Support Detachment  
Vieques, Puerto Rico

### SWMU 4 Beach Profile Transect Location



**Figure 2-5**  
**Beach Profile Offshore of SWMU 4**  
Expanded Site Inspection of UXO 16 adjacent to SWMU 4  
Former Naval Ammunition Support Detachment  
Vieques, Puerto Rico

# Summary of Field Activities

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This section describes the approach and methodology of the field investigation activities conducted during the UXO 16 ESI from April 1 to May 18, 2015. Field activities were conducted in general accordance with the QAPP; any deviations are discussed in the subsections below. Example photographs of the field activities are provided in **Appendix A**.

## 3.1 Investigation Approach

The underwater investigation approach included dividing the survey area into five zones based on exposure potential and likely occurrence of MEC/other MPPEH (varying from five to 25 percent coverage), as shown in **Figure 3-1**. Transects were established based on the target percent coverage within each zone (**Figure 3-2**).

### 3.1.1 Zone Coverage

Based on the results of the SI and the CSM, UXO 16 adjacent to SWMU 4 was divided into five key zones, designated as Zones A through E. As detailed in the QAPP, the quantity of data to be collected within each zone was based on the relative human exposure potential associated with likely and/or anticipated land use, the amount/type of MEC/other MPPEH potentially present, and the potential mobility of sediment/MEC/other MPPEH (which can also affect exposure potential). The zones and targeted underwater survey coverages are illustrated in **Figure 3-1**, and are described as follows:

- Zone A, targeted to be investigated at 25 percent coverage, is the area of highest exposure potential because of ready beach access and shallow sandy areas potentially supportive of wading. Zone A is also where the main ephemeral stream, which flows adjacent to the OB/OD areas, discharges into the ocean. Wave and current action within this zone can move sediment and, potentially MEC/other MPPEH.
- Zone B has a moderate human exposure potential because of lower beach accessibility and rocky, coral bottom, which would limit wading; this zone was targeted to be investigated at 15 percent coverage. Wave and current action within this zone can transport sediment and may move MEC/other MPPEH from Zone A (or already in Zone B), but that transport would likely be hindered by rocky bottom, which would tend to trap munitions-related items.
- Zone C has a relatively low exposure potential and was targeted to be investigated at 10 percent coverage. The beach in this area is not readily accessible due to the long distance from the road and being bounded by high cliffs. Recreational snorkeling/diving could occur, but wading would be difficult due to the abundance of jagged rock and coral. This zone has a relatively lower potential for MEC/other MPPEH to be located or moved due to distance from the OB/OD areas, the southerly wave direction, and because of the presence of coral reef habitat which would tend to trap munitions-related items.
- Zone D has a relatively low exposure potential and was targeted to be investigated at 10 percent coverage. This zone occurs greater than 400 feet offshore and is beyond the depth of where water depth is typically greater than 12 feet; therefore, snorkeling/diving from a boat may occur, swimming/snorkeling from shore would not be likely, and wading would not occur. Within this zone cross-shore transport could occur beyond the depth of closure only during extreme conditions, such as hurricanes.
- Zone E has a very low exposure potential and was targeted to be surveyed at five percent coverage. This zone extends from approximately 300 to 2,000 feet offshore, with depths approximately 15 to 30 feet. Snorkeling/diving from a boat may occur, swimming/snorkeling from shore would not be likely, and wading would not occur. The mobility of MEC/other MPPEH would be relatively low due to the greater depth of water and absence of wave and current effects on sediment (and potentially MEC/other MPPEH) mobility.

Historically, MEC/MPPEH SIs conducted on the former Vieques Naval Training Range (VNTR) have satisfied their objectives with approximately five percent coverage; the percent coverages listed previously are based on the

exposure potential, transport, and other information detailed for each zone in the ESI QAPP, Worksheet #10 (CH2M, 2014a).

### 3.1.2 Location of Transects

Initial planning for conducting underwater surveys of MEC/other MPPEH within each zone involved reviewing aerials and existing maps of underwater features (for example, bathymetric contours, shallow reef/rock locations, ephemeral stream deposits). As noted in the QAPP, the target percent coverages for each zone was the goal, with transect spacings, locations, and orientations adjusted as necessary (e.g., presence of shallow reef and/or threatened coral) and warranted (e.g., identification of sand channels). As a result, targeted transects were identified which factored in the following characteristics or limitations:

- Transect Spacing – Transects were generally spaced uniformly throughout each zone. In some instances zone transects were spaced somewhat closer together at the shoreward side of the zone to more conservatively survey areas closer to potential MEC/other MPPEH sources and where there is a greater potential for human exposure. Approximate, average spacings were as follows:
  - Zone A – 25 feet
  - Zone B – 30 feet
  - Zone C – 25 feet nearshore, 70 feet offshore
  - Zone D – 45 feet
  - Zone E – 75 feet nearshore, 150 feet offshore
- Transect Width – Transects were surveyed approximately four feet on either side of the transect centerline, for a total of approximately eight-foot width.
- Transect Orientation – Inside the depth of closure line (Zones A, B, and C), transects were oriented approximately parallel to depth contours because munitions-related items mobility and sand channels would likely align with depth contours, thereby increasing the likelihood of finding items and characterizing density. Outside the depth of closure line (Zones D and E), the same transect orientation was followed for convenience.
- Transect Limitations – Based on the review of aerials and bathymetric information, targeted transects were not placed in areas with obvious shallow reef or rock which would pose a safety hazard for waders/snorkelers/divers and/or potentially risk damaging sensitive species and habitats. These areas would also not likely be accessible/accessed by future users of the area for the same reasons. During the actual field investigation, some targeted transects were found to contain previously unidentified shallow reefs or jagged rock, sensitive corals near the water surface, and/or strong shoreline surf, making conditions unsuitable for wading, diving, snorkeling, or boating.

The final locations of completed survey transects in each of the five zones are illustrated in **Figure 3-2**. This figure also shows areas not surveyed due to the presence of shallow reefs, sensitive coral species, and jagged rock making conditions unsuitable for surveying (and likely future public access). A total of 14.2 acres of transects (14.6 miles) were surveyed, 1.5 acres greater than what was targeted (**Table 3-1**). Target coverage was either met (Zone C) or exceeded (all other zones) during the ESI.

UXO 16 ESI transect coverages and layouts are similar to or exceed designs associated with other MEC/other MPPEH investigations. For example, MEC/other MPPEH terrestrial SIs conducted on the former VNTR have satisfied their objectives with approximately five percent coverage; other than in Zone E (where six percent coverage was achieved), the ESI percent underwater coverages significantly exceeded the percent coverages of the terrestrial SIs.

In addition, an RI conducted at Culebra, Puerto Rico (USAE, 2015) included underwater surveys of MEC at two Munitions Response Sites (MRS), MRS-09 and MRS-13. The investigation transects were designed using Visual Sample Plan (VSP) software for detection of an MEC-contaminated area by determining elevated anomaly density areas with a 90 percent confidence level above a background density. The VSP-designed transects were realigned

to consider bathymetric contours and sensitive ecological receptors and critical habitat, similar to that performed for the UXO 16 ESI. For MRS-09, 3.6 miles of approximately parallel transects, three feet wide and spaced 225 feet apart, were surveyed in a coverage area of 132 acres, equating to a 1.1 percent coverage of the underwater area. For MRS-13, 15.7 miles of approximately parallel transects, three feet wide and spaced 250 feet apart, were surveyed in a coverage area of 543 acres, equating to a 1.2 percent coverage area. As demonstrated previously, the coverage targeted and achieved during the UXO 16 ESI significantly exceeded the RI coverage performed at Culebra.

At the Former Raritan Arsenal in Edison, New Jersey, an RI/FS is being conducted at multiple sites, including Area 12 which contains a 0.5-acre former OB/OD range (CH2M, 2014c). Area 12 encompasses 84 acres of upland along the Raritan River, however the maximum distance that munitions may have been kicked out during OB/OD operations is a radius of 1,000 feet, which extends approximately 500 feet southeast into the Raritan River. Underwater digital geophysical mapping (DGM) surveys are to be conducted in this underwater environment at 98-foot spacings, which is comparable to the UXO 16 spacings which range from 25 to 150 feet.

## 3.2 Field Methodology

### 3.2.1 Survey Transect Establishment

Survey transects were established along 300-foot long (or shorter) rope segments, intended to guide scientific and munitions divers during visual and detector-aided surveys. Initially, transect anchor points were located using global positioning system (GPS) and temporarily marked with a buoy tied to a small, soft weight. Munitions divers then conducted a detector-aided survey of the transect anchor points to verify that MEC/other MPPEH were not present. Temporary buoys were then replaced with a more heavily weighted transect anchoring system consisting of two concrete-weighted buckets (one at each end of the transect) tied to large floating buoys. The weighted buckets were slowly lowered to the bottom by a science diver, ensuring they were not placed where they may cause damage to threatened (or otherwise sensitive) corals. A transect rope was then clipped to these anchor lines and suspended off the bottom using small foam floats placed by scientific divers as they inspected the transect route for threatened (or otherwise sensitive) species. Ultimately, the rope was laid on the seabed in areas without threatened (or otherwise sensitive) species; where these species were identified, the rope was either moved slightly to one side (for isolated corals) or was suspended over the coral with the small foam floats (for more extensive corals). Example photographs of transect establishment are provided in **Appendix A**.

Where there was an abundance of threatened (or otherwise sensitive) species along most or all of the planned transect, surveys were conducted without the use of transect ropes. In these situations temporary buoys were placed at 300-foot spacings, and munitions divers would transit the routes between buoys using a compass bearing along with a towed surface marker that was monitored by surface support to ensure the divers stayed on the transect course.

### 3.2.2 Biological Resource Avoidance

UXO 16 contains a range of marine underwater habitat types including unconsolidated sediment (i.e., bare sand), submerged vegetation (i.e., seagrass communities, macroalgae communities), and coral reef/hardbottom (e.g., patch reef, colonized pavement, colonized bedrock). In addition, there are seven hard coral species federally listed as threatened in the Caribbean, all of which (except rough cactus coral) were observed during the site investigation. The seven species include the following:

- Staghorn coral (*Acropora cervicornis*)
- Elkhorn coral (*Acropora palmata*)
- Pillar coral (*Dendrogyra cylindrus*)
- Lobed star coral (*Orbicella annularis*)
- Mountainous star coral (*Orbicella faveolata*)
- Boulder star coral (*Orbicella franksi*)
- Rough cactus coral (*Mycetophyllia ferox*)

As part of the standard underwater investigation procedures, a scientific diver conducted a visual inspection of all survey transects to identify and implement avoidance measures as needed where threatened coral species, and generally sensitive reef and seagrass habitats were located. Avoidance measures included the following:

- No work (boating or diving) was conducted in areas where the listed coral species occurred in waters shallower than three feet or where the tops of the coral were within a few feet of the water surface. In such areas, planned transects were either re-routed or eliminated.
- All divers were instructed to limit physical contact with the benthic environment to the minimum extent needed to effectively conduct the work identified in the QAPP.
- Scientific divers were directly involved in the installation of transect anchor points and ropes, ensuring physical contact with protected corals was avoided. Anchors were positioned away from these corals, and transect ropes were floated off the bottom where they occurred, as described previously.
- After transect inspection, scientific divers relayed any relevant information to the munitions divers about the presence of sensitive species or habitats.

Example photographs of avoidance measures are provided in **Appendix A**.

### 3.2.3 Anomaly Locating, Excavation, and Identification

Munition response divers were responsible for detecting and retrieving possible MEC/other MPPEH along each transect to a depth of one foot, all in accordance with Standard Operating Procedure (SOP) 01 in the QAPP. Munitions response divers are Navy explosive ordnance disposal (EOD) personnel and/or contractor unexploded ordnance (UXO) qualified divers. A MineLab Excalibur II underwater all-metals detector was used to locate metal objects. The MineLab works by transmitting an electromagnetic field from the search coil into the sediment. Any metal objects within the electromagnetic field become energized and retransmit an electromagnetic field of their own. The detector's search coil receives the retransmitted field and alerts the munitions response diver by producing a hit response (sound).

MineLab quality control (QC) checks were conducted daily on the beach adjacent to the work site in accordance with the QAPP. Two Industry Standard Objects (small pipe nipples) were buried – one placed horizontally at approximately five inches depth, and one vertically at approximately nine inches (top of item) depth. The instrument verification strip (IVS) (also referred to as the equipment checkout area or ECA) checks were conducted before and after operations and recorded in a log each day. The instrument test was performed in-water. The morning QC instrument checks were entered with individual serial numbers noted for each of the two units used (a primary and backup). The afternoon checks were performed and logged on the unit(s) actually used that day. The Safety/QC Log with applicable entries was forwarded to the Senior UXO Supervisor (SUXOS) each day. Underwater QC procedures were performed in a manner replicating all facets of munitions response diver procedures and tools.

Additional underwater quality control was conducted to verify metal object detection performance along survey transects. Twenty percent of the first 10 transects were re-surveyed by a different munitions response diver, followed by 10 percent QC coverage of subsequent lots of 10. A QC failure within a transect would have occurred if an MEC item or metallic object equal to or greater than a 20-mm projectile in size was detected by the different munitions response diver; no QC failures occurred during the entire survey.

If metallic anomalies were identified beneath the surface, the munitions response divers carefully dug with hands and/or hand tools to a maximum of one foot before reporting the anomaly as below contract depth (BCD). BCDs were identified in Zone A (25 detections) and Zone B (three detections), but none were identified in the other zones (**Figure 3-3**). Using underwater to surface communications, munitions response divers relayed any anomaly discovery to surface support who documented the findings. Information included location of anomaly, description of the observed/excavated item, and whether it was confirmed or suspected to be MEC. Location coordinates for MEC/other MPPEH were obtained using a surface buoy/GPS tethered to a munitions response diver; the tether was tightened to place the GPS directly above the item location before marking location coordinates. Each

confirmed or suspected MEC/other MPPEH was then determined as safe or unsafe to move in accordance with SOP 04 in the UXO 16 ESI Dive Safety Plan. If deemed safe to move, items were taken back to the boat and placed in a cartridge casing until the end of the workday. Items were then taken by boat to the land-based magazine at SWMU 4 for classification, photographs, and temporary storage by two EOD/UXO qualified persons. No underwater items were identified as unsafe to move.

### **3.2.4 Disposition**

At the completion of the underwater investigation, all items recovered during the investigation were inspected by two trained and qualified individuals and transitioned to the Navy's Munitions Response contractor, USAE, for disposal. All items identified as MEC were consolidated with other MEC identified during the ongoing terrestrial removal actions and destroyed through open detonation. The items that were determined to be free of explosives were added to stockpiles of metal for processing and off-site disposal/recycling.

### **3.2.5 Exclusion Zone Monitoring**

An exclusion zone was maintained during all periods of potentially intrusive operations at UXO 16. A security boat was positioned offshore to monitor all coastal boat traffic, and to intercept all boats approaching the 3,000-foot exclusion zone boundary. There were several instances of the security boat making contact with nearby boats, which afterwards diverted their route. There was also a single instance of a boat refusing to leave the exclusion zone, after which work was shut down for the remainder of the day. On three occasions pedestrians occurred along the shoreline within the exclusion zone, but departed after being notified by security.

**TABLE 3-1**

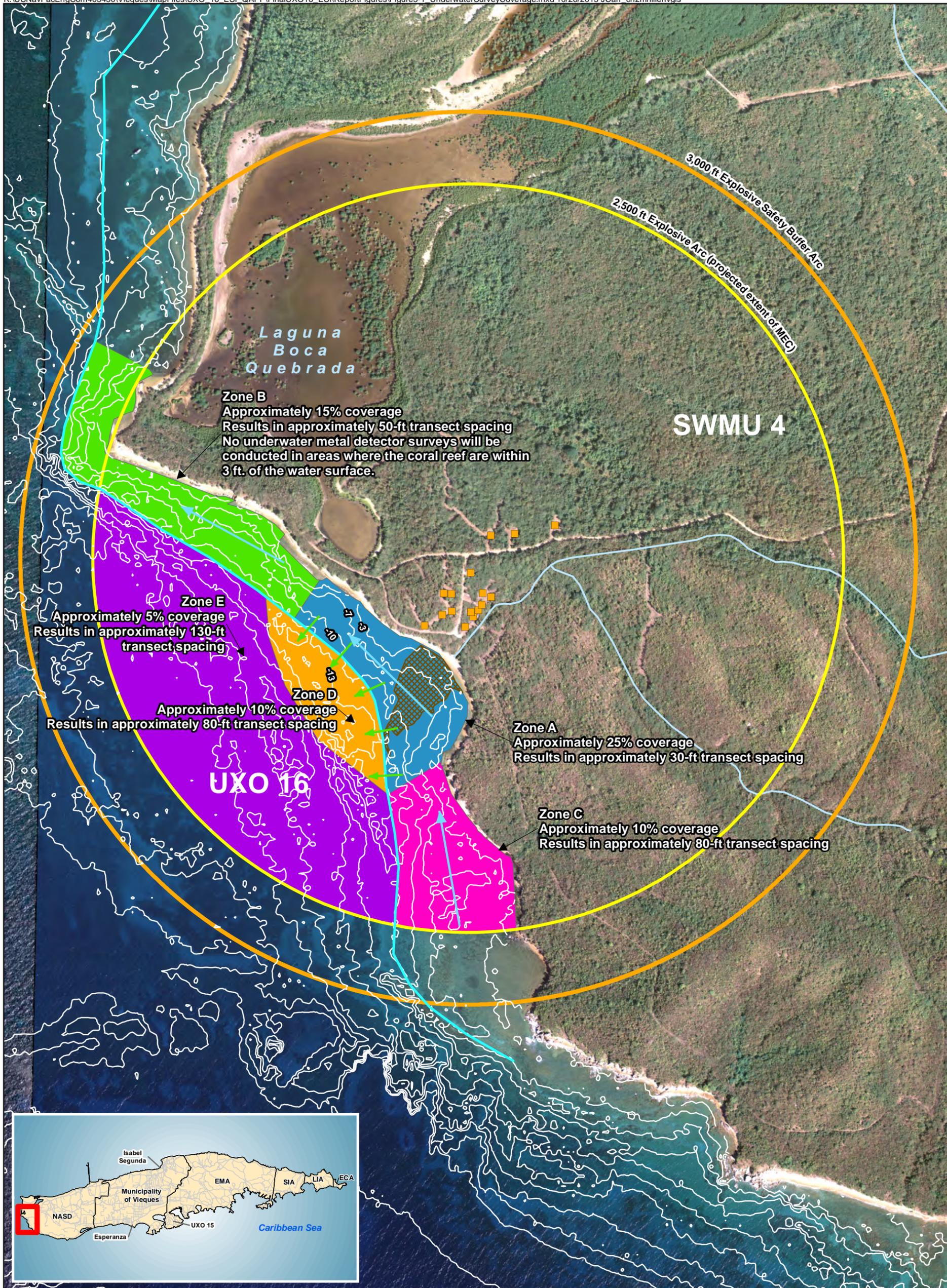
## Survey Area Coverage Results

*Expanded Site Inspection of UXO 16 adjacent to SWMU 4**Former Naval Ammunition Support Detachment, Vieques, Puerto Rico*

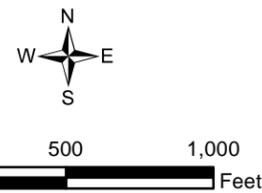
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<b>Zone</b>	<b>Zone Area (ac)</b>	<b>Target Zone Coverage (% / ac)</b>	<b>Final Area Surveyed (%/ac)</b>	<b>Linear Feet Surveyed (8 ft wide transects)</b>
<b>A</b>	15.5	25% / 3.9	26% / 4.1	22,590
<b>B</b>	19.6	15% / 2.9	16% / 3.2	17,230
<b>C</b>	15.4	10% / 1.5	10% / 1.6	8,591
<b>D</b>	10.5	10% / 1.0	16% / 1.7	9,150
<b>E</b>	65.0	5% / 3.3	6% / 3.6	19,720
Total	126.1	12.7	14.2	77,281

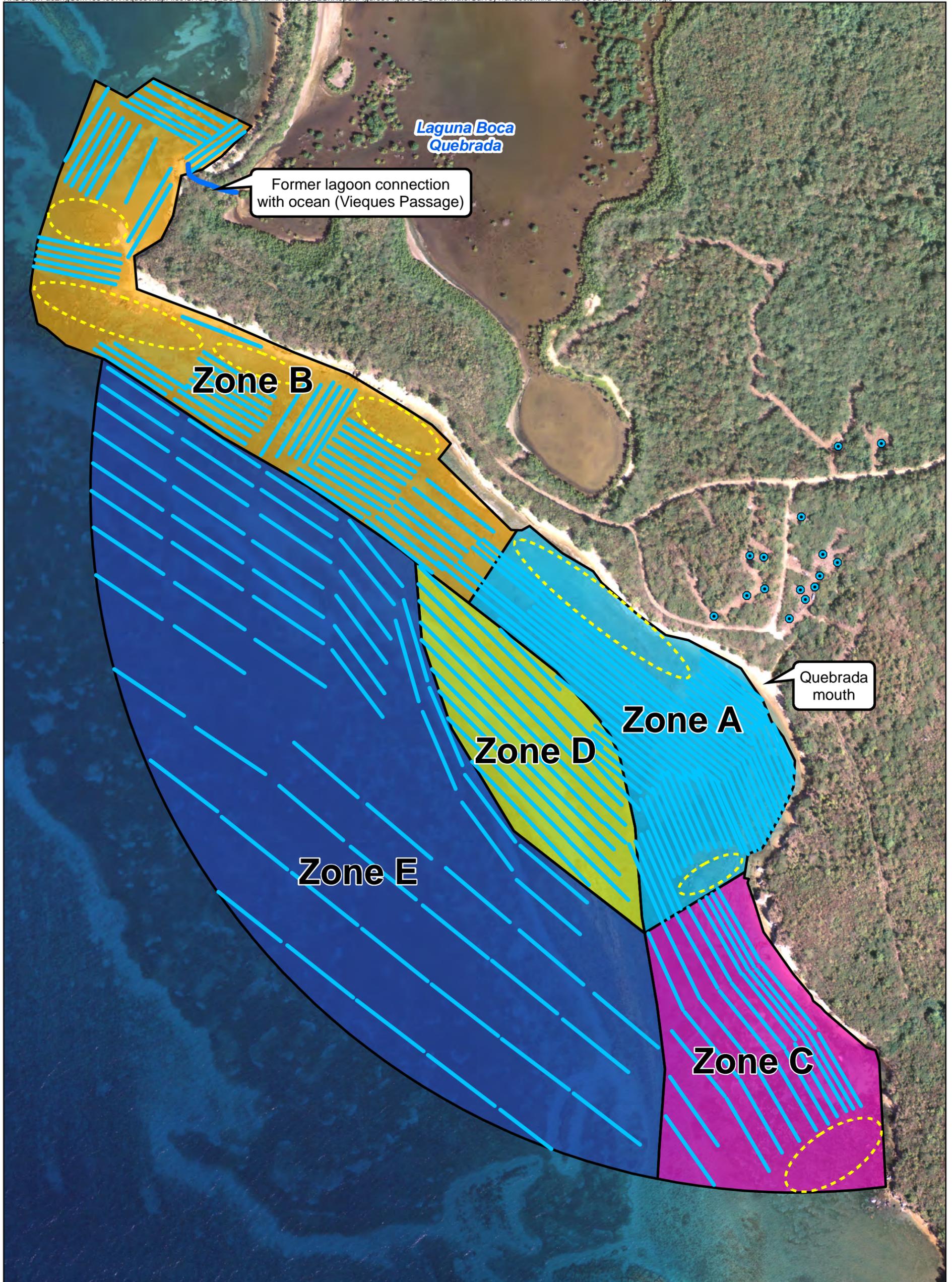
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- Legend**
- OB/OD Areas
  - Ephemeral Stream
  - Bathymetry Contour (feet)
  - Depth of Closure
  - Direction of Sediment Transport
  - Cross-Shore Sediment Transport During Extreme Conditions
  - ▨ Delta from Ephemeral Stream

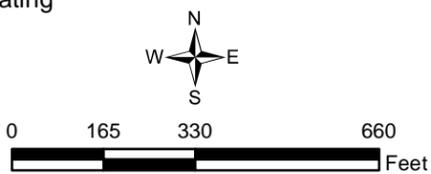


**Figure 3-1**  
**Underwater Survey Coverage**  
 Expanded Site Inspection of UXO 16 adjacent to SWMU 4  
 Former Vieques Naval Ammunition Support Detachment  
 Vieques, Puerto Rico

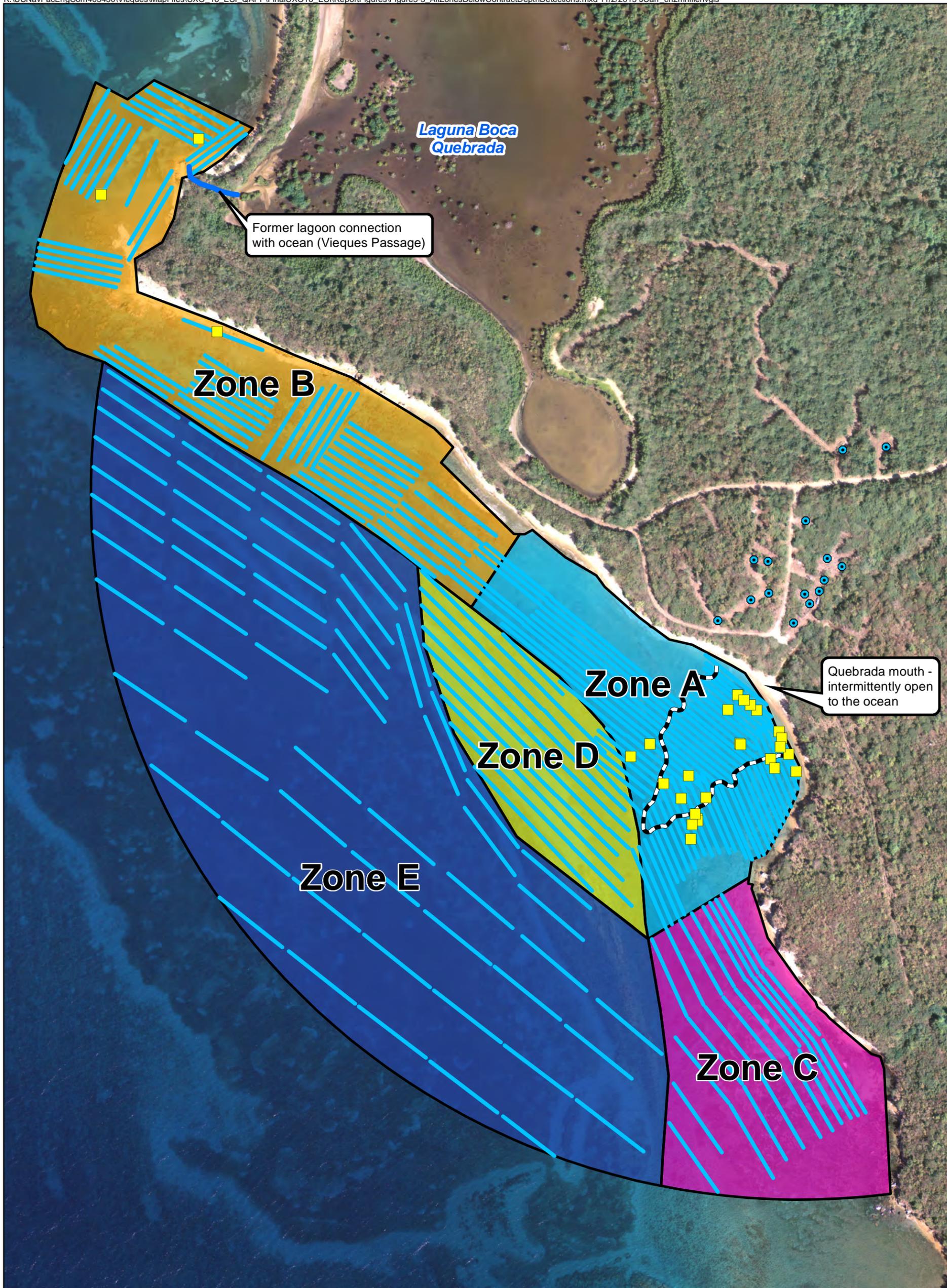


**Legend**

- OB/OD Areas
- Completed survey transect
- Area of shallow reef, sensitive coral species, or jagged rock making conditions unsuitable for walking, snorkeling, diving, or boating
- Zone A
- Zone B
- Zone C
- Zone D
- Zone E



**Figure 3-2**  
**Underwater Survey Transects**  
 Expanded Site Inspection of UXO 16 adjacent to SWMU 4  
 Former Vieques Naval Ammunition Support Detachment  
 Vieques, Puerto Rico



**Legend**

- Below Contract Depth (>12 inches) Detection
- OB/OD Areas
- General boundary of sand fan associated with quebrada
- Completed survey transect

- Zone A
- Zone B
- Zone C
- Zone D
- Zone E



**Figure 3-3**

**All Zones Below Contract Depth Detections**  
 Expanded Site Inspection of UXO 16 adjacent to SWMU 4  
 Former Naval Ammunition Support Detachment  
 Vieques, Puerto Rico

# Summary of Findings and Path Forward

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This section summarizes the findings of the SI and ESI and path forward for UXO 16, adjacent to SWMU 4. The number of items recovered during the ESI, as well as the SI, is summarized in **Table 4-1**. The locations of these items within each zone are illustrated in **Figures 4-1** through **4-6**. Details regarding the classification, sediment depth, and coordinates of all MEC/other MPPEH and MD identified during the ESI are provided in **Table 4-2**. Representative photographs of the munitions items are included in **Appendix B**. The munitions debris group classification of all items was done by UXO qualified technicians in the field. Specific identifiable features that were not clearly visible were not reported.

## 4.1 Results of Surveys

In total, three MEC (classified as DMM) were identified during the ESI and three items identified as MPPEH were found during the SI within UXO 16, offshore of SWMU 4 (**Figure 4-1**).

### 4.1.1 Site Inspection

Three MPPEH were identified during the SI on the sediment surface at three locations within Zone A, comprising a 20-mm projectile, an expended M123 series photoflash cartridge base section, and a 40-mm flare base section. The 20-mm projectile and photoflash cartridge were identified immediately offshore within the sand delta from the ephemeral stream. The flare base section was found near the southern extent of Zone A. Seventy-two additional metallic anomalies (that were identified as non MEC/MPPEH) were identified during the SI in Zone A. They were left in place, so some may have been identified again during the ESI.

### 4.1.2 Expanded Site Inspection

Of the entire 14.2 acres (14.6 miles of transects) surveyed as part of the ESI, only three DMM and 57 MD (poses no explosive hazard) were identified. All of the DMM were photoflash cartridges, which is a pyrotechnic cartridge designed to produce a brief/intense illumination for low altitude night-time photography. All DMM were located within approximately 50 to 350 feet offshore. The majority of the MD were identified within Zones A and D, located the closest to the OB/OD areas and the mouth of the ephemeral stream.

Non-munitions related debris (NMRD) was found in all zones. NMRD includes a wide range of cultural debris such as scrap metal, wire, cans, and fish/lobster trap parts, the majority of which were also in Zone A.

A summary of the DMM, MPPEH, and MD identified in each zone is provided below.

#### Zone A

Based on the CSM, Zone A has the highest potential to identify MEC/other MPPEH as this zone is nearest to the OB/OD areas and is where the ephemeral stream discharges to the ocean. While it is true that most were found in Zone A (i.e., 1 DMM during the ESI, and 3 other MPPEH during the SI), the total suggests only a very low quantity of items representing an explosive hazard are present (**Figure 4-2**). The highest number of MD (36 items) occurred within Zone A; 8 of these MD were 20-mm projectiles, but were non-explosive (**Tables 4-1 and 4-2**). In addition, 25 metallic signatures were detected below the investigation depth (beyond the investigation depth of 12 inches below the sediment surface) within Zone A (**Table 4-1**); however, based on the DMM/MD/NMRD percentage observed within the top foot of sediment, the number of these items estimated to be MEC is one or less.

#### Zone B

One DMM was retrieved from 5 feet of water at 2 inches below the sediment surface, approximately 950 feet to the west of the nearest OB/OD area within the southeastern portion Zone B (**Figure 4-1** and **Figure 4-3**). Only 5 MD were identified within Zone B (**Tables 4-1 and 4-2**). In addition, 3 metallic signatures were detected below the investigation depth within Zone B (**Table 4-1**); however, based on the DMM/MD/NMRD percentage observed within the top foot of sediment, the number of these items estimated to be MEC is one or less.

### Zone C

No MEC and only 1 MD was identified within Zone C (**Figure 4-4**). No metallic signatures were detected below the investigation depth.

### Zone D

One DMM was retrieved from 8 feet of water on the sediment surface, approximately 950 feet to the west of the nearest OB/OD area within Zone D (**Figure 4-1** and **Figure 4-5**). Zone D contained the next highest number of MD (12 items); all MD were found along the eastern half of Zone D, adjacent to Zone A and the sand delta from the ephemeral stream. No metallic signatures were detected below the investigation depth.

### Zone E

No MEC, MD, or metallic signatures below the investigation depth were detected within Zone E (**Figure 4-6**).

## 4.2 Nature and Extent

The nature and extent of munitions within UXO 16, offshore of SWMU 4, is consistent with what is expected based on the CSM. The majority of the MEC and MD identified within UXO 16, offshore of SWMU 4, were located immediately offshore in Zones A and D, the nearest locations to the OB/OD areas and the mouth of the ephemeral stream. No munitions were identified further offshore (within Zone E and seaward extents of Zones B, C, and D), which is consistent with sediment transport moving northwestward with the direction of the waves rather than from the beach to further offshore. The low quantities of munitions observed in Zone B suggest that the northwestward transport of munitions has occurred, but is minimal. This is consistent with the benign wave environment and presence of the coral reef habitat located within Zone B (**Figure 2-2**).

Additionally, the nature of the munitions showed significant signs of corrosion and heavy encrustation (**Appendix B**), which also suggest that the munitions have not been relatively mobile. Munitions casings primarily composed of aluminum (such as photoflash cartridges, flare base sections, etc.) showed less signs of corrosion as compared to the munitions casings composed primarily of steel and iron (i.e., 20-mm projectiles). Although a higher quantity of munitions (primarily 20-mm projectiles) and munitions-related debris was identified within the terrestrial environment of SWMU 4, the fact that most items found on land were 20-mm projectiles and the corrosive ocean environment are the likely reasons so few items are present offshore of SWMU 4.

No MEC or MD was identified near the former outlet of Laguna Boca Quebrada; therefore, the potential for transport of munitions from the lagoon into the ocean is likely negligible.

Based on the very few MEC/other MPPEH items found during the SI and ESI, deeper burial of MEC/other MPPEH within UXO 16, offshore of SWMU 4, is expected to be minimal. Benign wave conditions also limit the ability to bury munitions.

## 4.3 Path Forward

The nature and extent of MEC and MD has been sufficiently delineated to satisfy the objectives of an RI. However, since MEC/other MPPEH has the potential to release MC, the ERP Technical Subcommittee determined an RI for MC is necessary. The MC nature and extent information gathered during the RI and the MEC/MD nature and extent information gathered during the ESI will be compiled and evaluated in an RI/FS Report. The RI/FS Report will also include information gathered during the beach dynamics investigation offshore of SWMU 4 that is relevant to nature and extent, fate and transport, and remedial alternatives evaluation.

**TABLE 4-1**

## Summary of SI/ESI Findings

*Expanded Site Inspection of UXO 16 Adjacent to SWMU 4**Former Naval Ammunition Support Detachment, Vieques, Puerto Rico*

<b>Zone</b>	<b>DMM<sup>1</sup></b>	<b>Other MPPEH<sup>2</sup></b>	<b>MD</b>	<b>NMRD<sup>3</sup></b>	<b>BCD</b>
<b>A</b>	1	3	36	78	25
<b>B</b>	1	--	5	21	3
<b>C</b>	0	--	1	9	0
<b>D</b>	1	--	12	16	0
<b>E</b>	0	--	0	7	0
<b>Total</b>	<b>3</b>	<b>3</b>	<b>54</b>	<b>131</b>	<b>28</b>

DMM = Discarded military munitions

MPPEH - munitions potentially presenting an explosive hazard.

MD = Munitions debris (no explosive hazard)

NMRD = Non-munitions related debris (e.g., scrap metal, wire, cans, fish/lobster trap parts).

BCD = Below contract depth (&gt;12 inches); based on DMM/MD/NMRD percentage findings, the number of BD estimated to be MEC would equal 1 or less.

1 - each a photoflash cartridge (pyrotechnic cartridge designed to produce a brief/intense illumination for low altitude night-time photography), destroyed by detonation.

2 - All 3 items were found during the SI.

3 - The 72 metallic anomalies (non MEC/MPPEH) identified during the SI in Zone A are not included. They were left in place and therefore potentially identified again during the ESI.

**TABLE 4-2**

## Summary of Items Recovered

*Expanded Site Inspection of UXO 16 adjacent to SWMU 4**Former Naval Ammunition Support Detachment, Vieques, Puerto Rico*

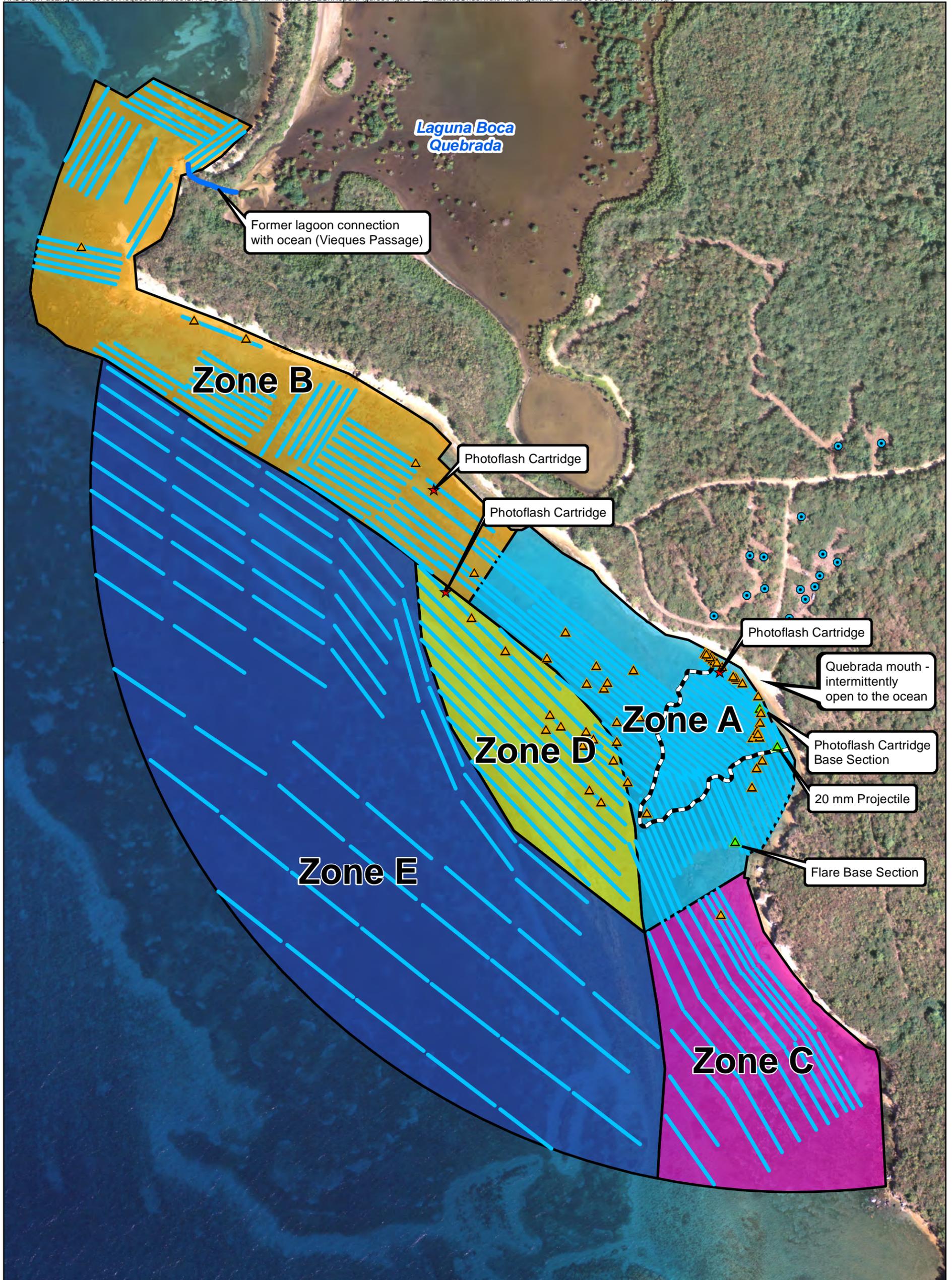
Database ID	Group	Class	Sediment Depth (inches)	Demo Required	Find Date	Zone - Transect	Coordinates (UTM)	
							X	Y
87093	MD	Scrap	0	None	2015-04-04	Zone A-60	227725	2002931
87095	MD	Scrap	10	None	2015-04-06	Zone A-63	227736.54	2002886.93
87096	MD	Scrap	0	None	2015-04-06	Zone A-63	227687.96	2002927.06
87094	MD	Scrap	0	None	2015-04-06	Zone A-87	227757.46	2002852.92
87097	MD	Scrap	0	None	2015-04-06	Zone A-62	227721.3	2002910.42
87106	MD	Scrap	0	None	2015-04-09	Zone A-71	227872	2002881
87105	MD	Scrap	0	None	2015-04-09	Zone A-70	227877	2002902
87104	MD	Scrap	3	None	2015-04-09	Zone A-67	227878.25	2002939.36
87103	MD	Scrap	6	None	2015-04-09	Zone A-67	227877.22	2002942.83
87098	MD	Scrap	6	None	2015-04-09	Zone A-68	227883.03	2002910.41
87099	MD	Scrap	6	None	2015-04-09	Zone A-68	227872.67	2002934.85
87100	MD	Scrap	2	None	2015-04-09	Zone A-67	227878.12	2002940.19
87101	MD	Scrap	2	None	2015-04-09	Zone A-67	227879.8	2002935.47
87102	MD	Scrap	6	None	2015-04-09	Zone A-67	227878.12	2002940.19
87121	MD	Scrap	2	None	2015-04-10	Zone A-66	227880.56	2002952.04
87111	MD	Scrap	2	None	2015-04-10	Zone A-40	227831.14	2003018.47
87110	MD	Scrap	2	None	2015-04-10	Zone A-40	227829.2	2003020.48
87109	MD	Scrap	5	None	2015-04-10	Zone A-40	227861.41	2002994.54
87108	MD	Scrap	4	None	2015-04-10	Zone A-40	227854.17	2003000.07
87107	MD	Scrap	4	None	2015-04-10	Zone A-40	227825.01	2003024.16
87119	MD	Scrap	4	None	2015-04-10	Zone A-42	227881.63	2002962.05
87122	MD	Scrap	4	None	2015-04-10	Zone A-40	227855.83	2002998.51
87117	MD	Scrap	6	None	2015-04-10	Zone A-40	227878.5	2002980.67
87116	MD	Scrap	2	None	2015-04-10	Zone A-40	227851.49	2003002.06
87115	MD	Scrap	2	None	2015-04-10	Zone A-40	227820.7	2003027.2
87114	MD	Scrap	2	None	2015-04-10	Zone A-40	227826.33	2003022.81
87120	DMM	Flares-Pyrotechnics	8	Demo	2015-04-10	Zone A-41	227836.83	2003005.91
87113	MD	Scrap	2	None	2015-04-10	Zone A-40	227833.69	2003016.87
87112	MD	Scrap	1	None	2015-04-10	Zone A-40	227839.36	2003012.13
87118	MD	Scrap	0	None	2015-04-10	Zone A-40	227822.34	2003025.95
87126	MD	Scrap	3	None	2015-04-14	Zone A-33	227711.02	2002988.94
87123	MD	Scrap	2	None	2015-04-14	Zone A-33	227749.75	2002957.31
87124	MD	Scrap	1	None	2015-04-14	Zone A-32	227714.48	2002995.03
87125	MD	Scrap	2	None	2015-04-14	Zone A-31	227702.47	2003013.22
87128	MD	Scrap	0	None	2015-04-15	Zone A-25	227648.87	2003021.67
87127	MD	Scrap	4	None	2015-04-15	Zone A-20	227669.15	2003049.96
87130	MD	Scrap	0	None	2015-04-16	Zone D-1	227567.04	2003065.67
87129	DMM	Flares-Pyrotechnics	0	Demo	2015-04-16	Zone D-1	227538.75	2003093.6
87131	MD	Scrap	6	None	2015-04-17	Zone D-11	227603.64	2003029.63
87132	MD	Scrap	0	None	2015-04-23	Zone B-50	227506.53	2003234.72
87142	MD	Scrap	0	None	2015-04-24	Zone D-22	227699.45	2002933.44
87133	MD	Scrap	6	None	2015-04-24	Zone D-22	227699.57	2002933.72
87134	MD	Scrap	1	None	2015-04-24	Zone D-22	227691.43	2002941.94
87135	MD	Scrap	0	None	2015-04-24	Zone D-23	227664.04	2002947.21
87136	MD	Scrap	3	None	2015-04-24	Zone D-23	227652.28	2002960.05
87137	MD	Scrap	3	None	2015-04-24	Zone D-27	227648.01	2002944.04
87138	MD	Scrap	10	None	2015-04-24	Zone D-30	227708.05	2002865.13
87139	MD	Scrap	3	None	2015-04-24	Zone D-30	227695.03	2002878.02
87140	MD	Scrap	0	None	2015-04-24	Zone B-24	227321.87	2003370.5
87141	MD	Scrap	0	None	2015-04-24	Zone B-24	227265.32	2003389.85

**TABLE 4-2**

Summary of Items Recovered

*Expanded Site Inspection of UXO 16 adjacent to SWMU 4**Former Naval Ammunition Support Detachment, Vieques, Puerto Rico*

Database ID	Group	Class	Sediment Depth (inches)	Demo Required	Find Date	Zone - Transect	Coordinates (UTM)	
							X	Y
87144	MD	Scrap	0	None	2015-05-12	Zone A-27	227743	2003009
87143	MD	Scrap	2	None	2015-05-12	Zone A-12	227570	2003115
87145	MD	Scrap	0	None	2015-05-13	Zone C-4	227838	2002742
87147	MD	Scrap	2	None	2015-05-14	Zone B-19	227143	2003470
87146	DMM	Flares-Pyrotechnics	2	Demo	2015-05-14	Zone B-62	227526	2003205
87149	MD	Scrap	0	None	2015-05-18	Zone A-36	227725	2002952
87148	MD	Scrap	0	None	2015-05-18	Zone A-34	227692	2002994



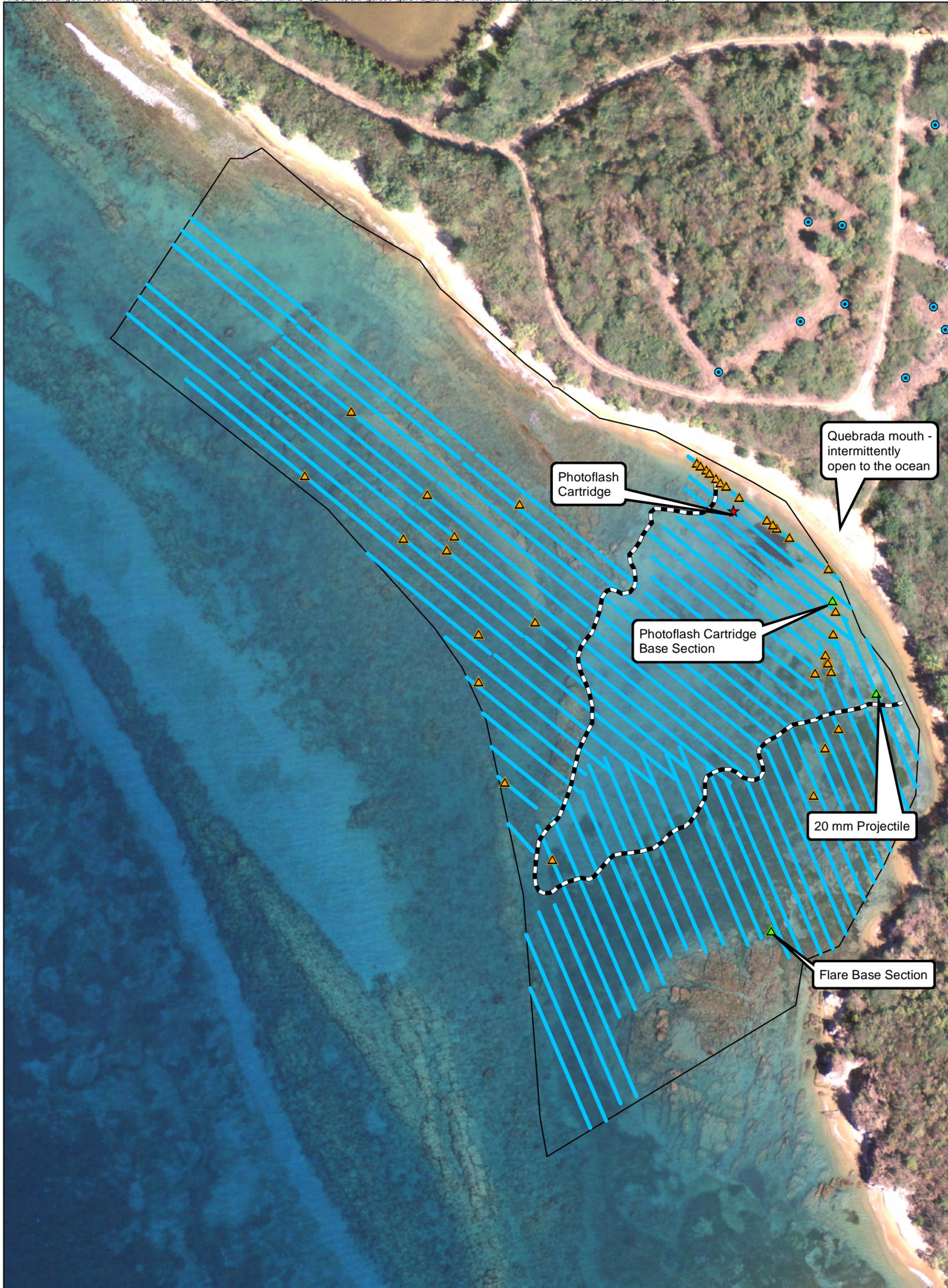
- Legend**
- OB/OD Areas
  - ★ DMM
  - ▲ MD
  - ▲ MPPEH (2012 Site Inspection)
  - General boundary of sand fan associated with quebrada
  - Completed survey transect

- Zone A
- Zone B
- Zone C
- Zone D
- Zone E



**Figure 4-1**

**All Zones Underwater Findings**  
 Expanded Site Inspection of UXO 16 adjacent to SWMU 4  
 Former Naval Ammunition Support Detachment  
 Vieques, Puerto Rico



- Legend**
- OB/OD Areas
  - ★ DMM
  - ▲ MD
  - ▲ MPPEH (2012 Site Inspection)
  - General boundary of sand fan associated with quebrada
  - Completed survey transect
  - Zone A



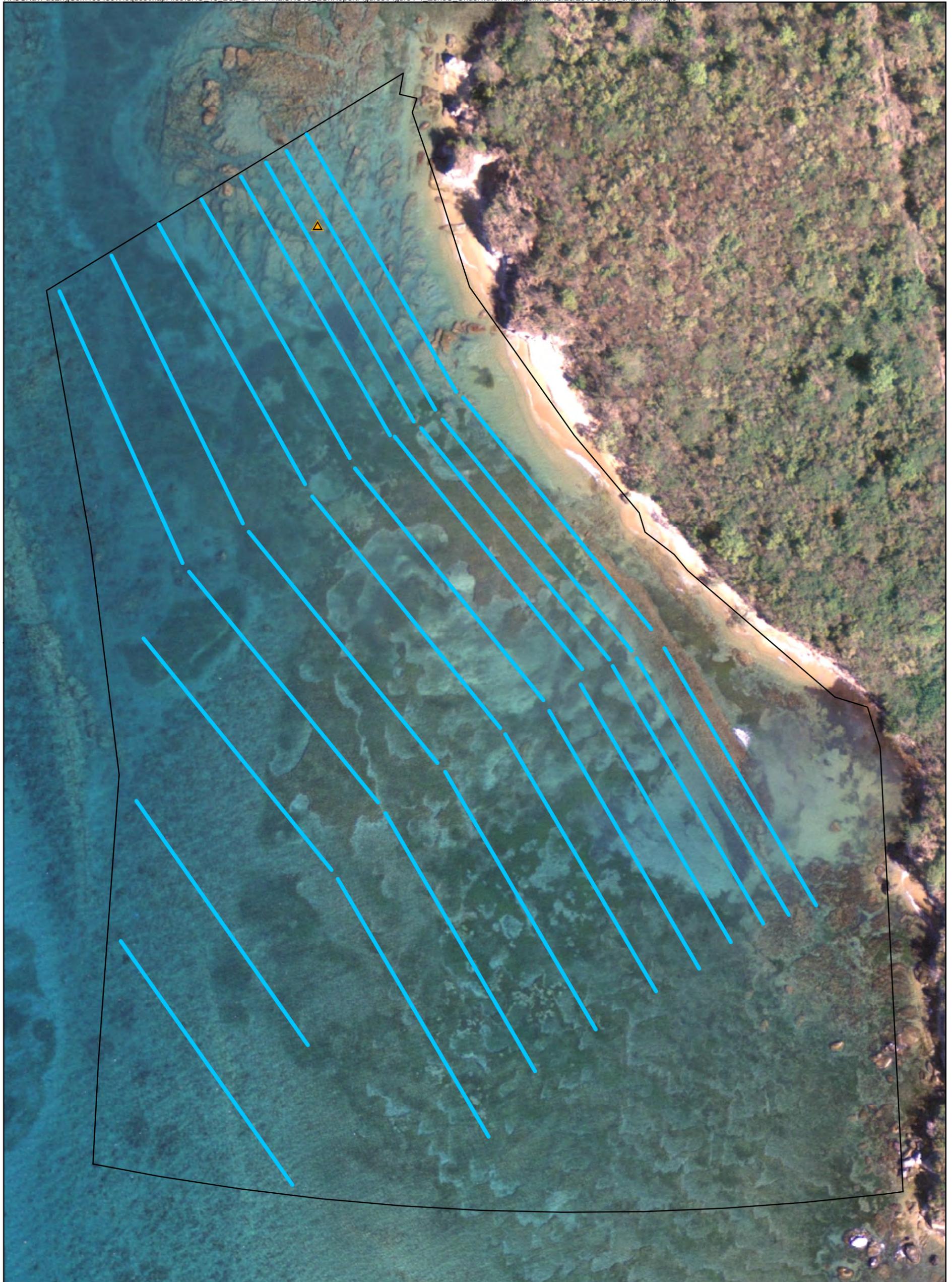
**Figure 4-2**  
**Zone A Underwater Findings**  
 Expanded Site Inspection of UXO 16 adjacent to SWMU 4  
 Former Naval Ammunition Support Detachment  
 Vieques, Puerto Rico



- Legend**
- ★ DMM
  - ▲ MD
  - Completed survey transect
  - Zone B

**Figure 4-3**  
**Zone B Underwater Findings**  
*Expanded Site Inspection of UXO 16 adjacent to SWMU 4*  
*Former Naval Ammunition Support Detachment*  
*Vieques, Puerto Rico*



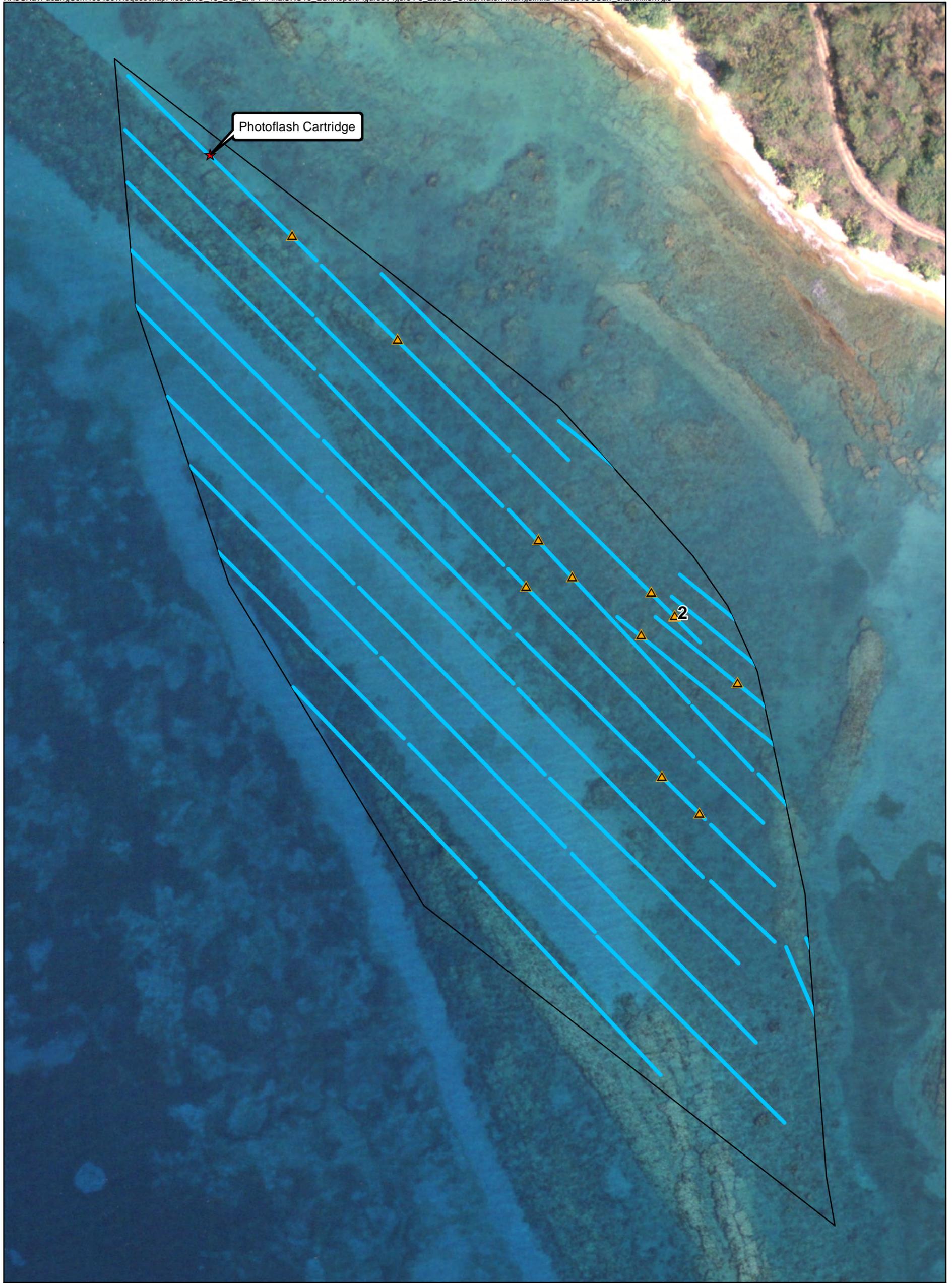


**Legend**  
▲ MD  
— Completed survey transect  
□ Zone C



0 50 100  
Feet

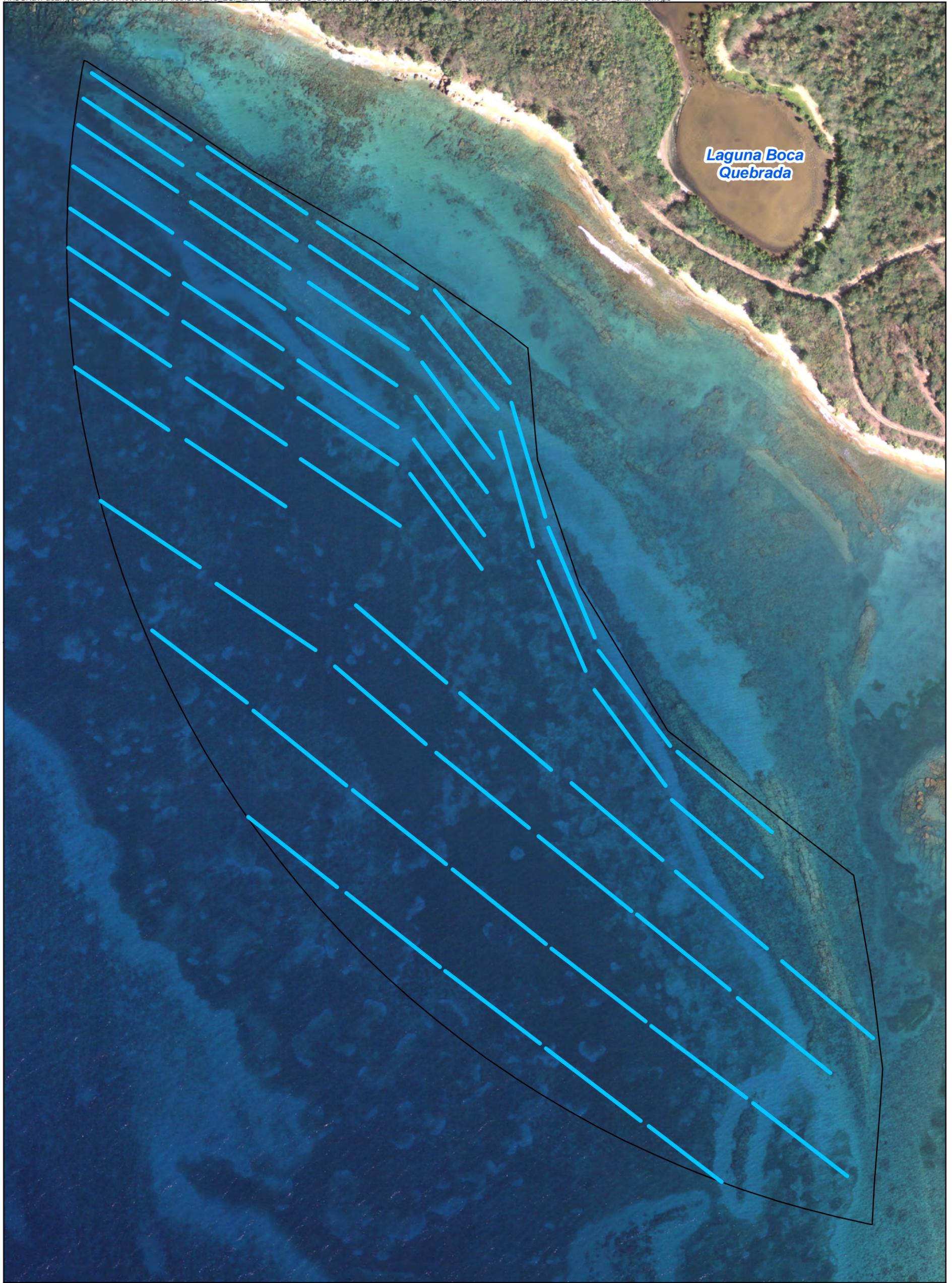
**Figure 4-4**  
**Zone C Underwater Findings**  
*Expanded Site Inspection of UXO 16 adjacent to SWMU 4*  
*Former Naval Ammunition Support Detachment*  
*Vieques, Puerto Rico*



- Legend**
- ★ DMM
  - ▲ MD
  - Completed survey transect
  - Zone D



**Figure 4-5**  
**Zone D Underwater Findings**  
*Expanded Site Inspection of UXO 16 adjacent to SWMU 4  
Former Naval Ammunition Support Detachment  
Vieques, Puerto Rico*



**Legend**  
— Completed survey transect  
□ Zone E



0 50 100 200 300 400  
Feet

**Figure 4-6**  
**Zone E Underwater Findings**  
*Expanded Site Inspection of UXO 16 adjacent to SWMU 4  
Former Naval Ammunition Support Detachment  
Vieques, Puerto Rico*

## SECTION 5

# References

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Caribbean Coastal Observing System (CariCOOS). [http://www.caricoos.org/drupal/swan\\_multigrid/NCER](http://www.caricoos.org/drupal/swan_multigrid/NCER).

CH2M HILL (CH2M). 2012a. *Remedial Investigation/Feasibility Study Report, Solid Waste Management Unit 4 (SWMU 4), Former Naval Ammunition Support Detachment (NASD), Vieques, Puerto Rico*. May.

CH2M. 2012b. *Status Report, Non-Time-Critical Removal Action, Interim Action for the Removal of Sub-Surface Munitions and Explosives of Concern at Solid Waste Management Unit 4 (SWMU 4), Former Naval Ammunition Support Detachment (NASD), Vieques, Puerto Rico*. July.

CH2M. 2014a. *Quality Assurance Project Plan, Beach Dynamics Investigation, Eleven Beaches at the Former Vieques Naval Training Range (VNTR) and the Former Naval Ammunition Support Detachment (NASD), Atlantic Fleet Weapons Training Area – Vieques, Vieques, Puerto Rico*. February.

CH2M. 2014b. *Quality Assurance Project Plan, Expanded Site Inspection of UXO 16 Adjacent to Solid Waste Management Unit 4, Atlantic Fleet Weapons Training Area-Vieques, Former Naval Ammunition Support Detachment, Vieques, Puerto Rico*. April.

CH2M. 2014c. *Remedial Investigation/Feasibility Study Work Plan, Former Raritan Arsenal, Edison, New Jersey*. April.

CH2M. 2014d. *Non-Time-Critical Interim Removal Action Work Plan, Former Open Burn/Open Detonation Site Solid Waste Management Unit 4 (SWMU 4), Atlantic Fleet Weapons Training Area-Vieques, Former Naval Ammunition Support Detachment, Puerto Rico*. June.

CH2M. 2014e. *Explosives Safety Submission for Underwater Areas at the Former Naval Ammunition Support Detachment and the Former Anchorage Areas, Vieques, Puerto Rico, Amendment 1*. December.

Craig, Harry D. and Taylor, Susan. 2011. *Framework for Evaluating the Fate, Transport, and Risks from Conventional Munitions Compounds in Underwater Environments*. November.

Hallermeier, R. J. 1981. A profile zonation for seasonal sand beaches from wave climate. *Coastal Engineering*, 4:253-277.

USA Environmental, Inc. (USAE). 2015. *Draft Final Remedial investigation Report, Culebra Island Site Puerto Rico*. September.

**Appendix A**  
**Investigation Photographic Log**

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*Munitions response underwater dive communications equipment preparation.*



*Diver equipment inspection.*



*Underwater communication system readied, along with dive and data logbooks.*



*Final munitions response diver check prior to water entry.*



*Initially, the endpoints of a 300-foot survey transect are located by GPS and temporarily marked with yellow floats tied to small, soft weights.*



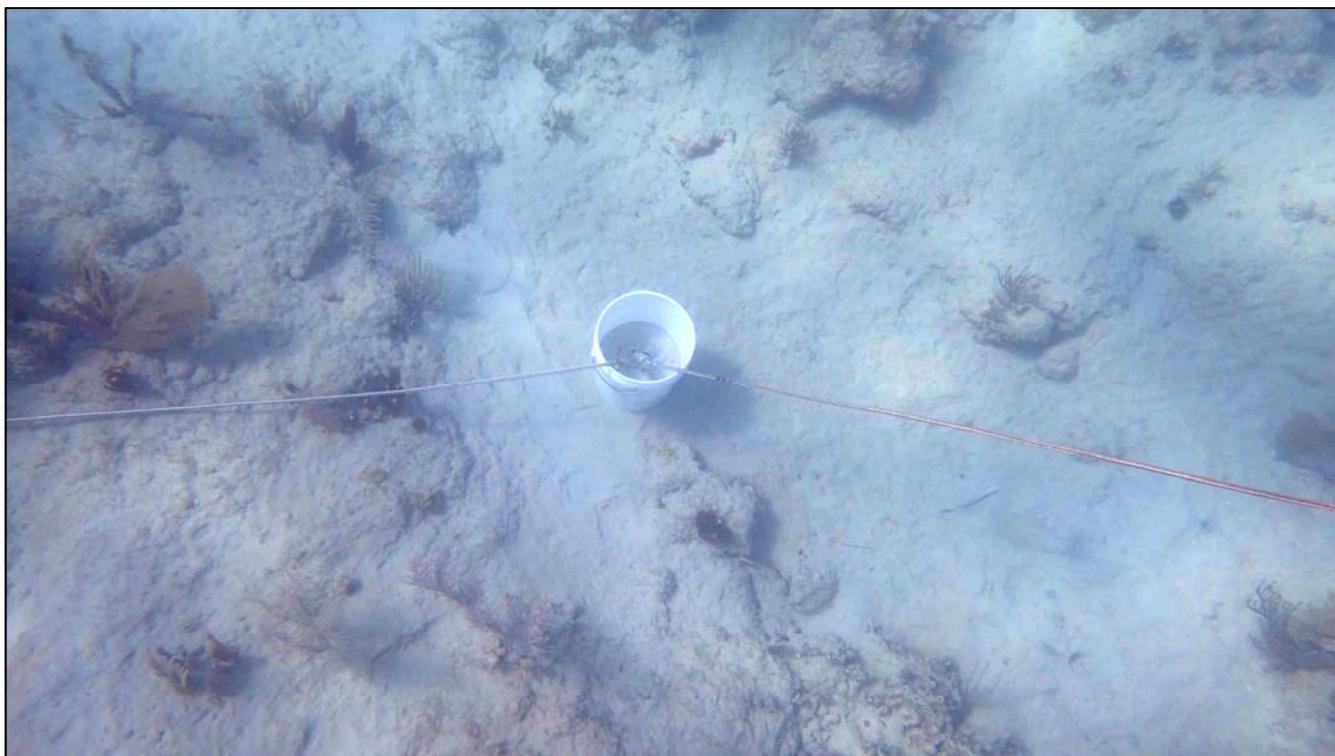
*After munitions response diver safety clearance of the float location, yellow floats are replaced with weighted buckets tied to large orange floats. A 300-foot surface line is then attached between the orange floats.*



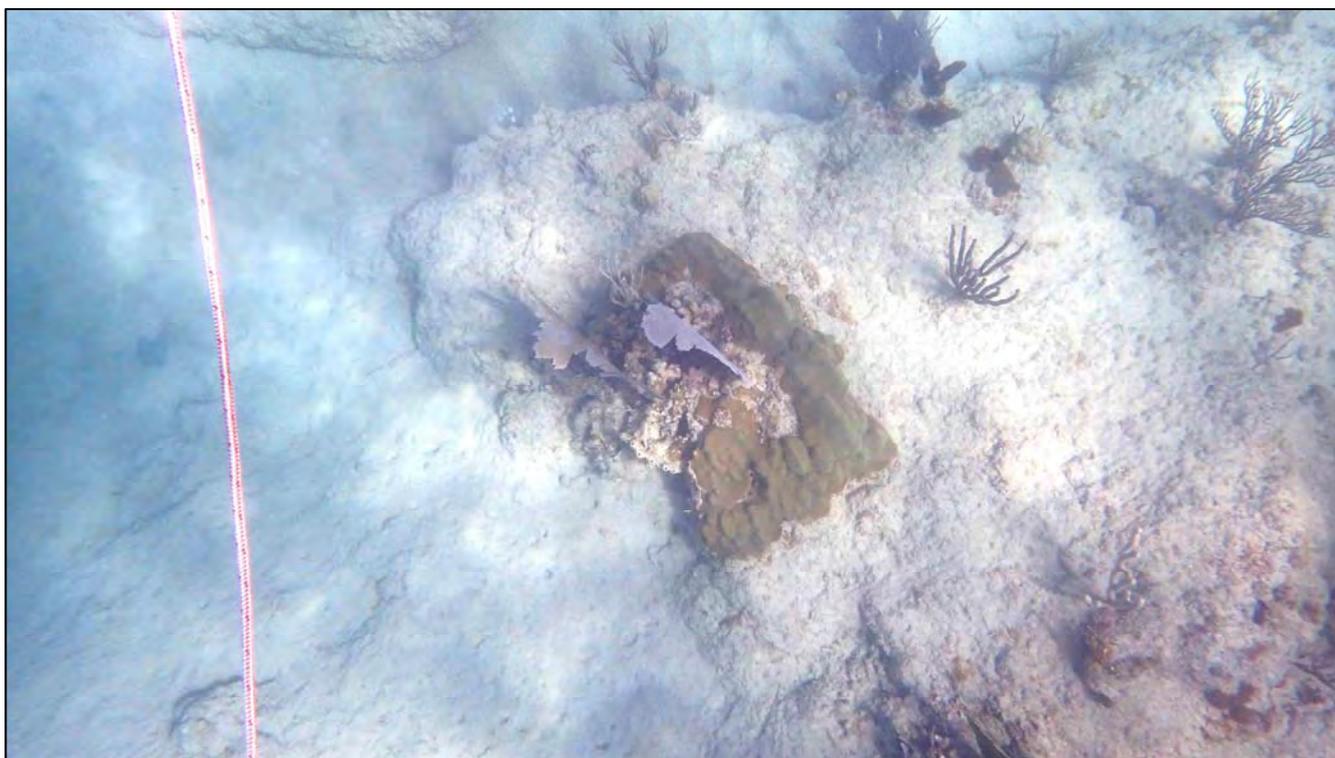
*Scientific divers swim the surface line to observe for sensitive coral species and inspect orange float anchor locations.*



*Where sensitive corals or habitats are located, the survey line is held above the ocean bottom with attached floats, otherwise the line is lowered to the bottom.*



*Example of weighted bucket positioned away from sensitive corals, and to which a 300-foot transect line and orange float line are attached.*



*Example of survey line adjusted to float above a mountainous star coral (*Orbicella faveolata*), classified as threatened (Zone B).*



. Listed coral example – elkhorn coral (*Acopora palmata*), classified as threatened (Zone B).



Example of survey line over seagrass habitat (*Thalassia testudinum* and *Syringodium filiforme*).



Listed coral example – lobed star coral (*Orbicella annularis*) in center, classified as threatened (Zone B).



Listed coral example – mountainous star coral (*Orbicella faveolata*), classified as threatened (Zone B).



*Munitions response divers deployed to conduct underwater surveys for munitions along a pair of parallel, 300-foot transects in Zone B.*



*Munitions response survey through seagrass habitat.*



*Munitions response survey through patch reef habitat (Zone D).*



*Munitions response survey of sand bottom habitat (Zone D).*

**Appendix B**  
**Munitions Related Items Photographic Log**

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*Item ID #: 87093*  
*Group: Munitions Debris*  
*Class: Scrap*  
*Description: Partial 20 mm cartridge casing*



*Item ID #: 87095*  
*Group: Munitions Debris*  
*Class: Scrap*  
*Description: Metal fragment*



*Item ID #: 87096*  
*Group: Munitions Debris*  
*Class: Scrap*  
*Description: Metal fragment*



*Item ID #: 87094*  
*Group: Munitions Debris*  
*Class: Scrap*  
*Description: Flare canister*



*Item ID #: 87097*  
*Group: Munitions Debris*  
*Class: Scrap*  
*Description: Bomb fuze MK 234*



*Item ID #: 87106*  
*Group: Munitions Debris*  
*Class: Scrap*  
*Description: Flare canister*



*Item ID #: 87105*  
*Group: Munitions Debris*  
*Class: Scrap*  
*Description: Flare canister*



*Item ID #: 87104*  
*Group: Munitions Debris*  
*Class: Scrap*  
*Description: Metal fragment*



*Item ID #: 87103*  
*Group: Munitions Debris*  
*Class: Scrap*  
*Description: Metal fragment*



*Item ID #: 87098*  
*Group: Munitions Debris*  
*Class: Scrap*  
*Description: Metal fragment*



*Item ID #: 87099*  
*Group: Munitions Debris*  
*Class: Scrap*  
*Description: Unknown component*



*Item ID #: 87100*  
*Group: Munitions Debris*  
*Class: Scrap*  
*Description: 20mm cartridge case*



*Item ID #: 87101*  
*Group: Munitions Debris*  
*Class: Scrap*  
*Description: 20mm cartridge case*



*Item ID #: 87102*  
*Group: Munitions Debris*  
*Class: Scrap*  
*Description: Partial 20mm TP projectile*



*Item ID #: 87121*  
*Group: Munitions Debris*  
*Class: Scrap*  
*Description: Disc*



*Item ID #: 87111*  
*Group: Munitions Debris*  
*Class: Scrap*  
*Description: Spacer for illumination projectile*



*Item ID #: 87110*  
*Group: Munitions Debris*  
*Class: Scrap*  
*Description: Disc*



*Item ID #: 87109*  
*Group: Munitions Debris*  
*Class: Scrap*  
*Description: Unknown munitions component*



*Item ID #: 87108*  
*Group: Munitions Debris*  
*Class: Scrap*  
*Description: Metal fragment*



*Item ID #: 87107*  
*Group: Munitions Debris*  
*Class: Scrap*  
*Description: Disc*



*Item ID #: 87119*  
*Group: Munitions Debris*  
*Class: Scrap*  
*Description: Disc*



*Item ID #: 87122*  
*Group: Munitions Debris*  
*Class: Scrap*  
*Description: Booster cup (empty)*



*Item ID #: 87117*  
*Group: Munitions Debris*  
*Class: Scrap*  
*Description: Booster cup (empty)*



*Item ID #: 87116*  
*Group: Munitions Debris*  
*Class: Scrap*  
*Description: Booster cup (empty)*



*Item ID #: 87115*  
*Group: Munitions Debris*  
*Class: Scrap*  
*Description: Booster cup (empty)*



*Item ID #: 87114*  
*Group: Munitions Debris*  
*Class: Scrap*  
*Description: Booster cup (empty)*



*Item ID #: 87120*  
*Group: Discarded Military Munitions*  
*Class: Flares-Pyrotechnics*  
*Description: Photoflash cartridge*



*Item ID #: 87113*  
*Group: Munitions Debris*  
*Class: Scrap*  
*Description: 20mm projectile partial, target practice*



*Item ID #: 87112*  
*Group: Munitions Debris*  
*Class: Scrap*  
*Description: 20mm projectile partial, target practice*



*Item ID #: 87118*  
*Group: Munitions Debris*  
*Class: Scrap*  
*Description: Metal fragment*



*Item ID #: 87126*  
*Group: Munitions Debris*  
*Class: Scrap*  
*Description: 20mm projectile*



*Item ID #: 87123*  
*Group: Munitions Debris*  
*Class: Scrap*  
*Description: Unknown munitions component*



*Item ID #: 87124*  
*Group: Munitions Debris*  
*Class: Scrap*  
*Description: Unknown munitions component*



*Item ID #: 87125*  
*Group: Munitions Debris*  
*Class: Scrap*  
*Description: Flare base*



*Item ID #: 87128*  
*Group: Munitions Debris*  
*Class: Scrap*  
*Description: Metal fragment*



*Item ID #: 87127*  
*Group: Munitions Debris*  
*Class: Scrap*  
*Description: Booster cup (empty)*



*Item ID #: 87130*  
*Group: Munitions Debris*  
*Class: Scrap*  
*Description: Metal fragment*



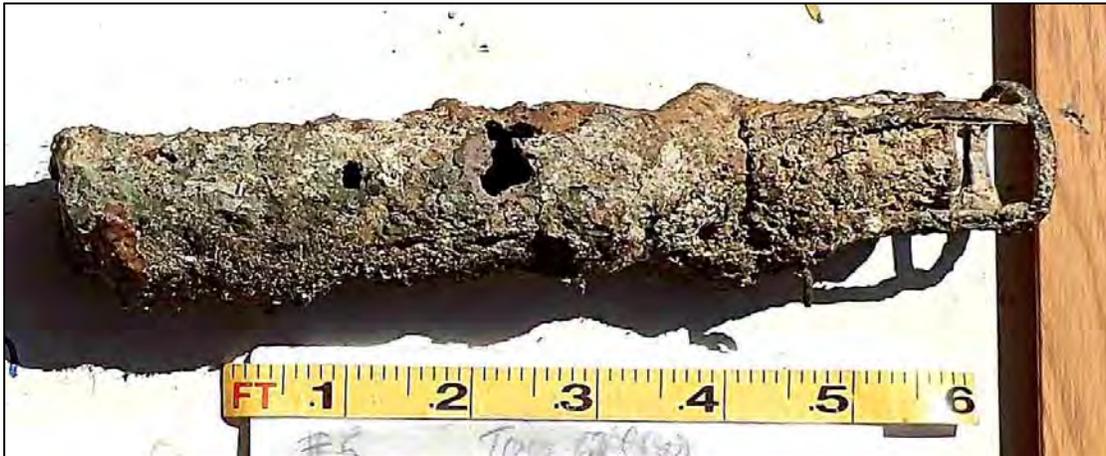
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*Group: Discarded Military Munitions*  
*Class: Flares-Pyrotechnics*  
*Description: Photoflash cartridge*



*Item ID #: 87131*  
*Group: Munitions Debris*  
*Class: Scrap*  
*Description: Metal fragment*



*Item ID #: 87132*  
*Group: Munitions Debris*  
*Class: Scrap*  
*Description: Metal fragment*



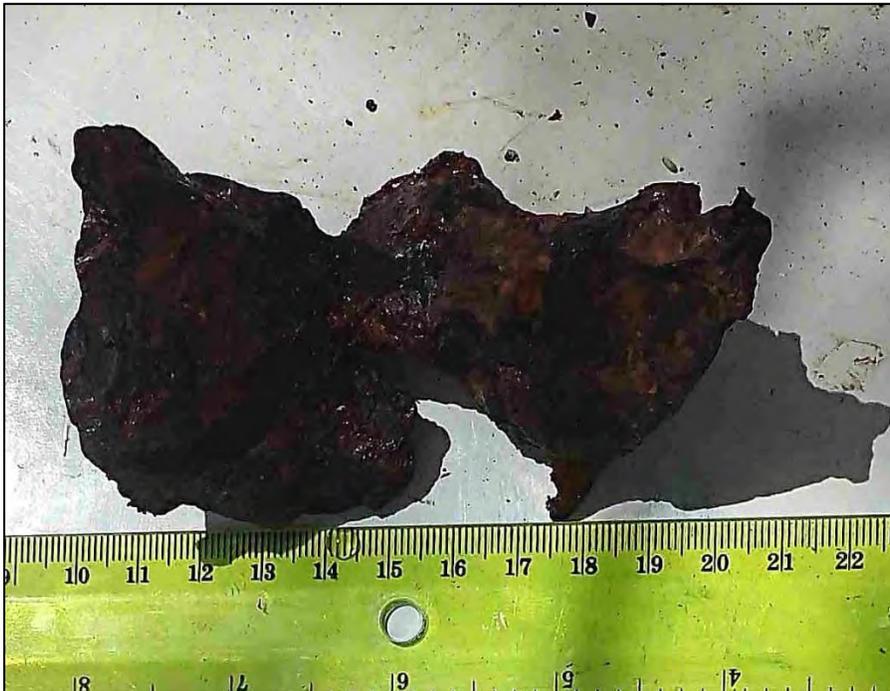
*Item ID #: 87142*  
*Group: Munitions Debris*  
*Class: Scrap*  
*Description: Flare*



*Item ID #: 87133*  
*Group: Munitions Debris*  
*Class: Scrap*  
*Description: Metal fragment*



*Item ID #: 87134*  
*Group: Munitions Debris*  
*Class: Scrap*  
*Description: Booster cup (empty)*



*Item ID #: 87135*  
*Group: Munitions Debris*  
*Class: Scrap*  
*Description: Metal fragment*



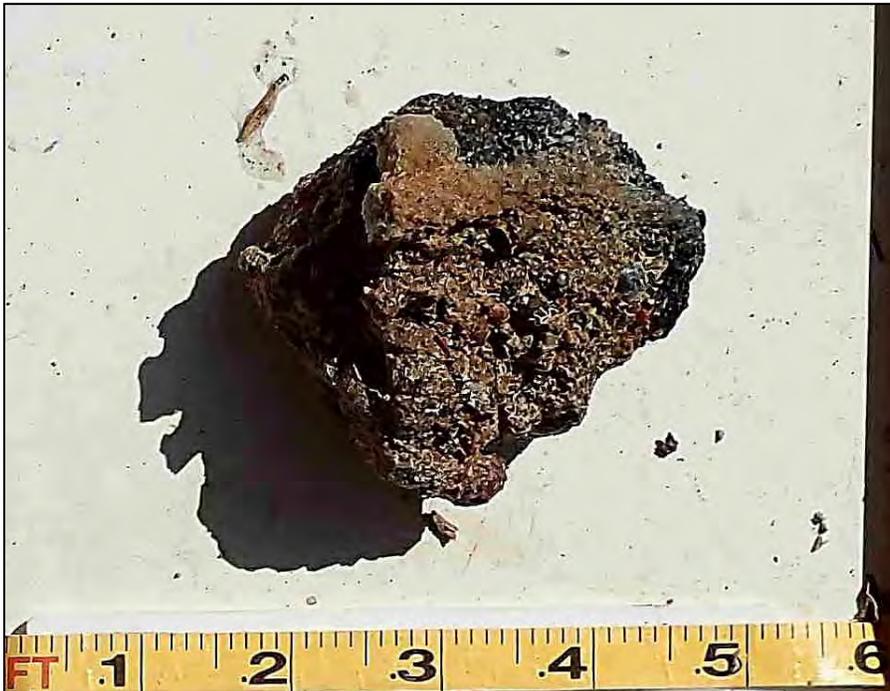
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*Class: Scrap*  
*Description: Metal fragment*



*Item ID #: 87137*  
*Group: Munitions Debris*  
*Class: Scrap*  
*Description: Unknown munitions component*



*Item ID #: 87138*  
*Group: Munitions Debris*  
*Class: Scrap*  
*Description: Metal fragment*



*Item ID #: 87139*  
*Group: Munitions Debris*  
*Class: Scrap*  
*Description: Metal fragment*



*Item ID #: 87140*  
*Group: Munitions Debris*  
*Class: Scrap*  
*Description: Booster cup (empty)*



*Item ID #: 87141*  
*Group: Munitions Debris*  
*Class: Scrap*  
*Description: Metal fragment*



*Item ID #: 87144*  
*Group: Munitions Debris*  
*Class: Scrap*  
*Description: Flare canister*



*Item ID #: 87143*  
*Group: Munitions Debris*  
*Class: Scrap*  
*Description: Metal fragment*



*Item ID #: 87145*  
*Group: Munitions Debris*  
*Class: Scrap*  
*Description: 2.75 inch warhead*



*Item ID #: 87147*  
*Group: Munitions Debris*  
*Class: Scrap*  
*Description: Unknown*



Item ID #: 87146  
Group: Discarded Military Munitions  
Class: Flares-Pyrotechnics  
Description: Photoflash cartridge



Item ID #: 87149  
Group: Munitions Debris  
Class: Scrap  
Description: Metal fragment



*Item ID #: 87148*  
*Group: Munitions Debris*  
*Class: Scrap*  
*Description: 20mm cartridge case*

**Appendix C**  
**Responses to Regulatory Comments**

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**Responses to EPA Comments on the  
DRAFT UXO 16 ADJACENT TO SOLID WASTE MANAGEMENT UNIT 4  
EXPANDED SITE INSPECTION REPORT  
DATED NOVEMBER 2015**

**SPECIFIC COMMENTS**

- 1. Acronyms and Abbreviations, Pages v and vi:** The acronym “MPPEH” is incorrectly defined. The correct definition is: “material potentially presenting an explosive hazard.” Also, the acronym “VSP” is incorrectly defined. The correct definition is “Visual Sample Plan.” Revise the text to correct these definitions.

**Navy Response:** Acronyms have been revised.

- 2. Section 1.3.1, SWMU 4, Page 1-2:** The second paragraph of this section states that, “MEC/other MPPEH classified as greater than 30-mm to 40-mm were generally found within a 1,000-foot radius of the OB/OD areas; however, less than eight percent of the MEC/other MPPEH recovered were larger than 30-mm. No MEC/other MPPEH has been found beyond the 2,500-foot arc (CH2M HILL, 2012b).” This is somewhat confusing as written. It appears to indicate that 30 to 40mm sized items were found within a 1,000-foot radius of the OB/OD areas. It then states that less than eight percent of the munitions were larger than 30mm. It is unclear what percent of these were greater than 40mm, if any. Revise the cited statements to provide the sizes of the munitions recovered in a more concise manner.

**Navy Response:** The text has been updated to remove the “to 40-mm.”

- 3. Section 2.3 Potential Receptors, page 2-2:** Potential receptors should include ecological (as shown on Figure 2-1 Conceptual Site Model) as well as human health receptors, as noted in the RI SAP Worksheet #10 (Conceptual Site Model), Potential receptors and exposure pathways.

**Navy Response:** The ESI was intended to identify only the presence of munitions, and not designed to identify potential chemical contamination (munitions constituents) which would be considered as part of a subsequent RI. Therefore, the ESI focused on addressing potential human receptors exposed to MEC/other MPPEH (i.e., explosive hazard) at UXO 16 such as beach users, divers/snorkelers, fishermen, and researchers. Though ecological receptors (exposed only to munitions constituents only) are included in the conceptual site model, it is not necessary to for the purpose of the ESI to include ecological receptors in Section 2.3.

- 4. Section 3.1.1, Zone Coverage, Page 3-1:** This section describes the percentages of the areas covered by the investigation that are based on exposure potential and likely occurrence of MEC/other MPPEH (varying from five to 25 percent coverage). However, no specific information is provided as to how these percentages were determined to be sufficient for the intended purpose. Further, as Zone D has numerous MDs and is located where snorkeling/diving from boat may occur, the exposure potential may not be “relatively low.” Revise the section to provide this information. (Note: Although some of this information is presented in the section that follows (i.e., Section 3.1.2, Location of Transects), it would be better if it were presented here in Section 3.2.1 to answer some of the questions that arise concerning the noted determinations.)

**Navy Response:** The following has been added to the end of Section 3.1.1: “Historically, MEC/MPPEH SIs conducted on the former VNTR have satisfied their objectives with approximately 5% coverage; the percent coverages listed above are based on the exposure potential, transport, and other information detailed for

each zone in the ESI QAPP, Worksheet #10 (CH2M HILL, 2014a).”

- 5. Section 3.1.2, Location of Transects, Page 3- 2:** The first bullet in this section states that, “In some instances zone transects were spaced somewhat closer together nearshore to more conservatively survey areas closer to potential MEC/other MPPEH sources and where there is a greater potential for human exposure.” No statement is provided as to the actual or approximate distance from the shore that constitutes “nearshore.” Revise the bullet or the section to include a statement as to what distance/distance range from the shore constituted “nearshore.”

**Navy Response:** The first bullet was modified as follows: “Transects were generally spaced uniformly throughout each zone. In some instances zone transects were spaced somewhat closer together at the shoreward side of the zone to more conservatively survey areas closer to potential MEC/other MPPEH sources and where there is a greater potential for human exposure.”

- 6. Table 4-1, Summary of SI/ESI Findings, Page 1 of 1:** The table definitions includes the following: “BCD = Below contract depth (>12 inches); based on DMM/MD/NMRD percentage findings, the number of BD estimated to be MEC would 1 or less.” It appears that the word “be” or the word “equals” is missing between the word “would” and the number “1” in the sentence. Make this correction.

**Navy Response:** Revised as requested.

**Minor Comment:**

1. EPA suggest that Attachment A, UXO 16 Adjacent to Solid Waste Management Unit 4 Expanded Site Inspection, be made a standalone document and not just an attachment to the UXO 16 RI/SAP.

**Navy Response:** At the July 2015 Technical Subcommittee meeting, the team concurred in general with the RI approach and to include the ESI Report as an appendix to the RI SAP instead of a standalone document because it will save significant time (i.e., accelerate the CERCLA process in this area). However, since this approach will have met this objective once all reviews are completed, when the RI SAP is finalized, the ESI Report will be removed and finalized as a separate report.

**Responses to PREQB Comments on the  
Draft UXO 16 Adjacent to Solid Waste Management Unit 4  
Expanded Site Inspection Report  
Atlantic Fleet Weapons Training Area – Vieques  
Former Naval Ammunition Support Detachment Vieques, Puerto Rico**

**PAGE-SPECIFIC COMMENTS**

- a. Potential Receptors and Exposure Pathways, and ESI Subsection 2.3: Please clarify why the primary document (RI SAP) references both human health and ecological receptors, both of which are referenced in the text and on Figure 6, but the ESI Subsection 2.3 offers only a discussion of human health receptors and does not discuss any ecological receptors, yet ecological receptors are noted on Figure 2-1 in the ESI (which is the same as Figure 6 in the RI SAP). Please consider adding a discussion of ecological receptors in the ESI.

**Navy Response:** The objective of the ESI was to identify the presence of munitions, not designed to identify potential chemical contamination (munitions constituents), which is the focus of the RI. Therefore, the ESI noted the ecological receptors, but focused on the potential human receptors that could be exposed to MEC/other MPPEH (i.e., explosive hazard). Though ecological receptors (exposed only to munitions constituents) are included in Figure 2-1 of the ESI, it is not necessary for the purpose of the ESI to expand on ecological pathways; they are more appropriately discussed in the SAP CSM associated with the MC RI, which is, in part, designed to evaluate potential effects of MC contamination (if present) on ecological receptors.

1. ESI: Section 3.1.2 uses two examples of other underwater investigations (Culebra and Raritan Arsenal, NJ) to support the adequacy of the Vieques ESI. EQB recommends removing this information on the two other underwater projects because all MEC sites are different and inserting brief summaries of other projects is irrelevant to this project. For example, the Raritan Arsenal underwater project took place in a river with zero visibility which invalidates the comparison of the transect spacing for that project with Vieques where divers had good visibility and a clear view of the ocean floor. There are substantial differences with the Culebra project that invalidate the comparisons made there as well. In addition, the brief summaries aren't fully developed (for example the CSMs aren't fully explained) and are, therefore, presented out of context. Removing the text associated with these two projects is not necessary to support the adequacy of the Vieques project and is highly recommended.

**Navy Response:** At the July 2015 Technical Subcommittee Meeting, EPA and NOAA requested that transect percentage coverage from the Culebra and Raritan investigations be referenced to help justify transect spacing in the ESI. The Navy concurs that providing these examples is appropriate because it helps put into perspective the approach taken during the ESI.

2. Figure 2-1 (ESI): Please consider addressing the legend for the bathymetric contours by changing the symbol background to blue with white lines, rather than open white box.

**Navy Response:** Revised as requested.